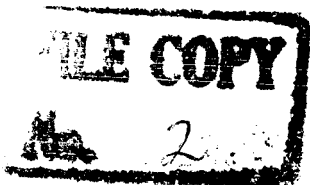


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MEMORANDUM

AN EXPERIMENTAL INVESTIGATION OF AN AIRPLANE
CONFIGURATION HAVING A TWISTED AND CAMBERED
TRIANGULAR WING OF ASPECT RATIO 2.2

By Gene P. Menees

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MEMORANDUM 5-19-59A

AN EXPERIMENTAL INVESTIGATION OF AN AIRPLANE
CONFIGURATION HAVING A TWISTED AND CAMBERED
TRIANGULAR WING OF ASPECT RATIO 2.2*

By Gene P. Menees

SUMMARY

An investigation has been conducted to determine the aerodynamic characteristics of an airplane configuration having a twisted and cambered triangular wing of aspect ratio 2.2. Provision was made for testing the twisted and cambered wing with a cambered leading-edge modification designed to improve the subsonic drag characteristics. A symmetrical wing having the same plan form, aspect ratio, and thickness distribution was also tested to provide a basis for comparison.

The results of the investigation showed that the twisted and cambered wing model achieved a positive increment of trim lift coefficient above that of the untrimmed symmetrical wing model at all test Mach numbers with little or no increase in drag. The increment of trim lift coefficient decreased with increasing Mach number to very small values at supersonic speeds. The addition of the cambered leading-edge modification to the twisted and cambered wing resulted in drag reductions at the high subsonic and low supersonic speeds without incurring undue drag penalties at the higher supersonic Mach numbers or adversely affecting the trimming capabilities. The lift and longitudinal stability characteristics of the model having the twisted and cambered wing with and without the modified leading edge and the lateral-directional characteristics of the model having the twisted and cambered wing with the modified leading edge were not significantly different from those of the symmetrical wing model.

INTRODUCTION

The achievement of high lift-drag ratios is of primary importance for efficient flight at supersonic speeds. One approach to this problem

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is the optimization of the wing from the standpoint of drag due to lift, which for most supersonic aircraft forms a large percentage of the total airplane drag. The theoretical studies of references 1 and 2 have shown that it is possible to twist and camber a triangular wing for a given Mach number and for a specified lift acting at a specified position so that the drag due to this lift is close to the theoretical minimum. Furthermore, it was shown in reference 3 that the subsonic drag characteristics of such a wing would probably be improved by the use of a leading-edge camber similar to conical camber (see refs. 4 and 5).

In the present investigation a triangular wing alone of aspect ratio 2.2 was twisted and cambered according to the method of reference 1 to be trimmed at a positive lift coefficient at a Mach number of 2.00. For testing purposes, this wing was separated along the root chord and the panels mounted on the fuselage of a contemporary fighter airplane. There was no theoretical basis for this procedure of combining the wing with the fuselage, and it was expected that the design characteristics for the wing alone would be penalized as a consequence. Provision was also made for testing the twisted and cambered wing with a leading-edge modification designed according to the principles of reference 3 to improve the subsonic drag characteristics. To provide a basis for comparison, a symmetrical wing of identical plan form, aspect ratio, and thickness distribution was also tested on the same fuselage.

NOTATION

b	span of experimental wing, ft
b_c	span of calculated wing, ft
$\bar{c}$	mean aerodynamic chord of experimental wing, ft
$\bar{c}_c$	mean aerodynamic chord of calculated wing, ft
C_D	drag coefficient, $\frac{\text{drag}}{qS}$
C_L	lift coefficient, $\frac{\text{lift}}{qS}$
C_m	pitching-moment coefficient referred to the point at $0.275\bar{c}$, $\frac{\text{pitching moment}}{qS\bar{c}}$
C_l	rolling-moment coefficient, $\frac{\text{rolling moment}}{qSb}$

C_n	yawing-moment coefficient, $\frac{\text{yawing moment}}{qSb}$
C_y	side-force coefficient, $\frac{\text{side force}}{qS}$
c_{rc}	root chord of calculated wing, ft
M	free-stream Mach number
q	free-stream dynamic pressure, lb/sq ft
S	area of experimental wing (formed by extending the leading and trailing edges to the fuselage reference center line), sq ft
x, y, z	Cartesian coordinates of the calculated twisted and cambered wing in streamwise, spanwise, and vertical directions, respectively (The origin is at the apex of the calculated wing.)
x', y', z'	x, y, z made dimensionless by c_{rc} , $b_c/2$ and c_{rc} , respectively
α	angle of attack of fuselage reference center line, deg
β	sideslip angle, measured between relative wing and fuselage reference center line, deg

APPARATUS

Test Facility

The experimental investigation was conducted in the Ames 6- by 6-foot supersonic wind tunnel which is a closed-circuit variable-pressure type with a Mach number range continuous from 0.70 to 2.24. The test-section floor and ceiling are perforated to enable uniform flow to be maintained at transonic and low supersonic speeds. A somewhat more detailed description of the test facility is presented in reference 6.

The models were sting supported in the wind tunnel and the forces and moments were measured with an internal, electrical, strain-gage type six-component balance.

Description of Models

Three models were tested during the investigation, each comprising an indented fuselage with faired inlets, a low-aspect-ratio vertical tail, and either a symmetrical wing, a twisted and cambered wing, or the twisted and cambered wing with a modified leading edge. All of the wings had an aspect-ratio-2.2 triangular plan form and a modified NACA 0003.9-65 thickness distribution streamwise. A photograph and dimensional sketch of the model having the twisted and cambered wing without the modified leading edge are shown in figures 1(a) and 1(b), respectively.

The shape of the twisted and cambered wing investigated in combination with the fuselage was based on a shape calculated for a triangular wing alone. The calculated wing was twisted and cambered according to the method of reference 1 for minimum drag due to lift at trim at supersonic speeds. (This wing is designated as β in ref. 1.) To derive the required shape to give minimum drag due to lift at trim, the condition must be satisfied that at the design Mach number the center of the design lift acts at the specified center of moments resulting, therefore, in zero pitching moment. For the wing of the present investigation these conditions were as follows:

1. Mach number, 2.00
2. Lift coefficient, 0.136
3. Moment center, 36 percent of mean aerodynamic chord of calculated wing

It was considered of interest to test the calculated wing in combination with a fuselage. To do this, the calculated wing was parted along the root chord and the panels were mounted on the fuselage so that the lift would be zero when the angle of attack of the fuselage reference center line was 0° . No attempt was made to account for interference effects between the wing and fuselage. The design center of moments of the calculated wing ($0.36\bar{c}_c$) corresponded to a point at 44.8 percent of the mean aerodynamic chord of the experimental wing, that is, the wing formed by extending the leading and trailing edges to the fuselage reference center line (see fig. 1(c)). To maintain adequate stability throughout the Mach number range of the investigation it was necessary to locate the experimental center of moments at 27.5 percent of the mean aerodynamic chord of the experimental wing. There was no theoretical basis for the aforementioned procedure of combining the calculated wing with the fuselage, and it was expected that the design characteristics envisaged for the wing alone would be penalized as a consequence.

To improve the drag characteristics at subsonic speeds, provision was made for fitting the twisted and cambered wing with a modified leading edge incorporating a camber similar to conical camber. A discussion of the analytical means and procedure used in the derivation of the leading-edge camber is presented in reference 3. A plot of the mean camber lines of the twisted and cambered wing with and without the modified leading edge is shown in figure 1(d) with the angle of attack of the fuselage reference center line at 0° .

TESTS AND PROCEDURE

Range of Test Variables

Experimental data were obtained during the investigation over a Mach number range from 0.70 to 2.20 through an angle-of-attack range of approximately -4° to $+20^\circ$ with sideslip angle constant at 0° and $+5^\circ$, and through an angle-of-sideslip range of -4° to $+8^\circ$ with angle of attack constant at 0° and $+5^\circ$. Sideslip data were not obtained for the configuration employing the twisted and cambered wing without the modified leading edge. The test Reynolds number based on the mean aerodynamic chord of the experimental wing was 2.35 million at Mach numbers of 2.20 and 2.00, and 2.95 million at all other Mach numbers. The smaller Reynolds number at the higher supersonic speeds was necessary because of wind-tunnel limitations.

At the low Reynolds numbers at which most wind tunnels operate, extensive regions of laminar flow can exist on models when no lift is developed. At lifting conditions the transition points on the wing, fuselage, and vertical tail usually move forward, thus causing a change in the friction drag with changing lift coefficient which is difficult to evaluate and, moreover, not necessarily representative of full scale. To isolate the effects of twist and camber on the drag due to lift characteristics of the test models, it was necessary to minimize the variation of friction drag with lift coefficient. In the present investigation this was accomplished by inducing transition at fixed locations on the wing, fuselage, and vertical tail by means of 0.010-inch-diameter wires located at the positions shown in figure 1(b). The wire size was selected on the basis of the results of reference 7 wherein it was shown that such a device was effective in promoting turbulent flow. Although there is no conclusive evidence as to the magnitude of the form drag coefficient increment contributed by the transition wires, previous studies have shown this increment to be not more than 0.0010. All of the data presented herein are for wire-on conditions.

Reduction of Data

The data presented herein have been reduced to standard coefficient form. The lift and drag coefficients were referred to the wind axes system while the side-force coefficient was referred to the stability axes. The pitching-moment, rolling-moment, and yawing-moment coefficients were referred to the stability axes with the origin at $0.275\bar{c}$. Corrections applied to the experimental results are listed in the following paragraphs.

Stream variations.- The experimental data were corrected for small stream angularities which were as much as $\pm 0.30^\circ$. The correction was obtained from tests of the symmetrical wing model in the upright and inverted positions.

Base drag.- The base pressure was measured and the data were adjusted to correspond to a base pressure equal to the free-stream static pressure.

RESULTS AND DISCUSSION

The complete results of the investigation are tabulated in tables I through IV. A portion of the data is also presented graphically in figures 2 and 3. The basic longitudinal characteristics of the model having the twisted and cambered wing with and without the modified leading edge are compared with those of the model having the symmetrical wing in figure 2 for the range of test Mach numbers. The data of figure 3 present a comparison of the lateral-directional characteristics of the twisted and cambered wing model having the modified leading edge with those of the symmetrical wing model for angles of sideslip of 0° and 5° .

Drag Characteristics

The results of figure 2, which presents the longitudinal characteristics of the test models, show that the twisted and cambered wing model achieved a positive increment of trim lift coefficient above that of the untrimmed symmetrical wing model at all test Mach numbers. The magnitude of the increment of trim lift coefficient decreased with increasing Mach number to very low values at supersonic speeds. At subsonic speeds the drag at the lift coefficient for trim was less than that of the untrimmed symmetrical wing model at the same lift coefficient. At supersonic speeds, small drag penalties were incurred with the small increments of trim lift coefficient that were achieved.

The addition of the cambered leading-edge modification to the twisted and cambered wing resulted in drag reductions at the high subsonic and low supersonic speeds above lift coefficients of 0.10 and 0.25, respectively (see figs. 2(a) and 2(b)). These gains were achieved without incurring undue drag penalties at the higher supersonic Mach numbers or adversely affecting the trimming capabilities of the twisted and cambered wing.

Lift and Moment Characteristics

The results of figure 2 substantiate the well-known facts that the aerodynamic center and lift-curve slope near zero lift are primarily functions of wing geometry and are not influenced by twist and camber. The lift and pitching-moment curves of the model having the twisted and cambered wing with and without the leading-edge modification were displaced from but were essentially parallel to those of the symmetrical wing model. The small positive increment in the angle of zero lift is of little significance, but as discussed previously, the positive shift in pitching moment, the magnitude of which decreased with increasing Mach number, would reduce the moment needed for trim and, therefore, the trim drag of the model.

Lateral-Directional Characteristics

The data of figure 3 show that the lateral-directional characteristics of the model with the twisted and cambered wing and modified leading edge were not significantly different from those of the model with the symmetrical wing.

CONCLUSIONS

An investigation has been conducted to determine the aerodynamic characteristics of an airplane configuration having a twisted and cambered triangular wing of aspect ratio 2.2. The investigation also included the evaluation of a leading-edge modification designed to improve the subsonic drag characteristics of the twisted and cambered wing. The results of this study showed:

1. The model having the twisted and cambered wing achieved a positive increment of trim lift coefficient above that of the model having the untrimmed symmetrical wing at all test Mach numbers with little or no

increase in drag. The increment of trim lift coefficient decreased with increasing Mach number to very small values at supersonic speeds.

2. Addition of the cambered leading-edge modification to the twisted and cambered wing resulted in drag reductions at the high subsonic and low supersonic speeds without incurring undue drag penalties at the higher supersonic Mach numbers or adversely affecting the trimming capabilities.

3. The lift and longitudinal stability characteristics of the model having the twisted and cambered wing with and without the modified leading edge and the lateral-directional characteristics of the model having the twisted and cambered wing with the modified leading edge did not differ significantly from those of the symmetrical wing model.

Ames Research Center

National Aeronautics and Space Administration
Moffett Field, Calif., Feb. 18, 1959

REFERENCES

1. Kainer, J. H.: Calculation of Optimum Supersonic Delta Wings. Convair Report No. ZA-259, Oct. 30, 1957.
2. Adams, Gaynor J., and Boyd, John W.: An Experimental Investigation of a Triangular Wing of Aspect Ratio 2 and a Body Warped to be Trimmed at $M = 2.24$. NASA MEMO 2-3-59A, 1959.
3. Falk, Theodore J.: Leading-Edge Shapes for Twisted and Cambered Delta Wings. Convair Report No. ZA-268, Oct. 14, 1957.
4. Boyd, John W., Migotsky, Eugene, and Wetzel, Benton E.: A Study of Conical Camber for Triangular and Sweptback Wings. NACA RM A55G19, 1955.
5. Phelps, E. Ray, and Boyd, John W.: A Wind-Tunnel Investigation of the Effects of Conical Camber for an Airplane Configuration Having a Triangular Wing of Aspect Ratio 2.2. NACA RM A57A10, 1957.
6. Boyd, John W., and Peterson, Victor L.: Static Stability and Control of Canard Configurations at Mach Numbers From 0.70 to 2.22 - Longitudinal Characteristics of a Triangular Wing and Canard. NACA RM A57J15, 1958.

7. Winter, K. G., Scott-Wilson, J. B., and Davies, F. V.: Methods of Determination and of Fixing Boundary-Layer Transition on Wind Tunnel Models at Supersonic Speeds. R.A.E. TN Aero. 2341, (British), Sept. 1954.

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TABLE I.- AERODYNAMIC CHARACTERISTICS THROUGH ANGLE-OF-ATTACK
RANGE AT $\beta = 0^\circ$

(a) Symmetrical wing configuration

M	α , deg	C_L	C_D	C_m	C_i	C_Y	C_n	M	α , deg	C_L	C_D	C_m	C_i	C_Y	C_n
0.70	-0.6	-0.255	0.0299	0.0238	-0.0008	0.000	0.0006	1.70	-0.5	-0.190	0.0380	0.0343	-0.0003	-0.001	0.0008
	-2.4	-0.142	0.0178	0.0142	-0.0006	0.000	0.0005		-2.2	-0.099	0.0264	0.0177	-0.0003	-0.001	0.0006
	-0.2	-0.035	0.0133	0.0047	-0.0006	0.000	0.0003		0.0	-0.008	0.0221	0.0006	-0.0004	-0.001	0.0004
	0.9	0.015	0.0131	0.0007	-0.0005	0.000	0.0001		1.0	0.033	0.0222	-0.0073	-0.0004	-0.001	0.0004
	2.0	0.066	0.0138	-0.0038	-0.0005	0.000	0.0000		2.1	0.077	0.0237	-0.0159	-0.0004	-0.001	0.0004
	3.1	0.122	0.0164	-0.0088	-0.0003	0.000	-0.0001		3.3	0.124	0.0273	-0.0252	-0.0003	-0.001	0.0004
	4.3	0.182	0.0219	-0.0137	-0.0005	0.000	-0.0002		4.5	0.170	0.0327	-0.0340	-0.0003	-0.001	0.0003
	6.5	0.298	0.0387	-0.0234	-0.0005	-0.001	-0.0004		6.7	0.253	0.0478	-0.0504	-0.0002	-0.002	0.0004
0.90	8.8	0.422	0.0672	-0.0316	-0.0009	-0.002	-0.0006	2.00	9.0	0.338	0.0703	-0.0674	-0.0001	-0.003	0.0004
	-4.6	-0.289	0.0340	0.0419	-0.0009	-0.001	0.0006		11.2	0.416	0.0980	-0.0831	0.0000	-0.004	0.0004
	-2.3	-0.155	0.0187	0.0235	-0.0006	0.000	0.0004		13.4	0.488	0.1306	-0.0966	0.0002	-0.005	0.0004
	0.0	-0.035	0.0137	0.0083	-0.0005	0.000	0.0002		15.8	0.562	0.1708	-0.1107	0.0001	-0.006	0.0004
	1.1	0.022	0.0137	0.0015	-0.0005	0.000	0.0001		-4.1	-0.140	0.0319	0.0209	-0.0004	-0.001	0.0005
	2.2	0.082	0.0147	-0.0056	-0.0005	0.000	0.0000		-1.9	-0.061	0.0230	0.0076	-0.0004	0.000	0.0004
	3.4	0.147	0.0186	-0.0135	-0.0006	0.000	-0.0001		0.2	0.014	0.0202	-0.0057	-0.0004	0.000	0.0004
	4.6	0.213	0.0258	-0.0208	-0.0006	-0.001	-0.0002		1.2	0.049	0.0206	-0.0122	-0.0004	0.000	0.0004
1.20	6.9	0.354	0.0497	-0.0383	-0.0005	-0.002	-0.0002	2.20	2.3	0.086	0.0225	-0.0191	-0.0003	-0.001	0.0003
	-4.5	-0.266	0.0434	0.0618	-0.0004	-0.001	0.0003		3.4	0.124	0.0261	-0.0265	-0.0002	-0.001	0.0003
	-2.1	-0.134	0.0282	0.0360	-0.0001	0.000	0.0001		4.5	0.161	0.0311	-0.0332	-0.0002	-0.001	0.0002
	0.2	-0.013	0.0232	0.0110	-0.0002	0.000	0.0000		6.7	0.226	0.0439	-0.0449	0.0000	-0.001	0.0002
	1.4	0.048	0.0234	-0.0008	-0.0001	0.000	-0.0002		8.9	0.295	0.0626	-0.0577	-0.0001	-0.002	0.0002
	2.6	0.112	0.0259	-0.0139	-0.0001	0.000	-0.0002		11.0	0.357	0.0850	-0.0694	-0.0001	-0.003	0.0002
	3.8	0.180	0.0316	-0.0280	0.0000	0.000	-0.0002		13.2	0.418	0.1120	-0.0806	0.0000	-0.004	0.0003
	4.9	0.245	0.0395	-0.0415	0.0000	0.000	-0.0003		15.4	0.479	0.1437	-0.0905	0.0001	-0.005	0.0003
1.50	7.2	0.371	0.0631	-0.0669	0.0000	-0.002	-0.0002	2.40	-3.9	-0.128	0.0303	0.0155	-0.0005	0.000	0.0004
	9.7	0.497	0.0983	-0.0925	-0.0002	-0.003	-0.0001		-1.7	-0.060	0.0224	0.0049	-0.0005	0.000	0.0003
	11.9	0.609	0.1399	-0.1151	0.0000	-0.004	0.0001		0.4	0.008	0.0198	-0.0065	-0.0005	0.000	0.0003
	-4.6	-0.217	0.0402	0.0430	-0.0004	-0.002	0.0007		1.4	0.039	0.0203	-0.0117	-0.0004	0.000	0.0003
	-2.3	-0.111	0.0273	0.0218	-0.0004	-0.001	0.0006		2.5	0.072	0.0222	-0.0176	-0.0004	0.000	0.0003
	0.0	-0.008	0.0224	0.0011	-0.0004	0.000	0.0004		3.5	0.102	0.0248	-0.0221	-0.0003	-0.001	0.0003
	1.1	0.043	0.0228	-0.0089	-0.0004	0.000	0.0003		4.6	0.137	0.0291	-0.0288	-0.0003	-0.001	0.0002
	2.2	0.095	0.0248	-0.0197	-0.0004	-0.001	0.0003		6.8	0.198	0.0410	-0.0395	-0.0003	-0.001	0.0003
1.70	3.4	0.148	0.0289	-0.0303	-0.0003	0.000	0.0002	2.60	9.0	0.259	0.0574	-0.0505	-0.0002	-0.002	0.0003
	4.6	0.203	0.0354	-0.0415	-0.0003	-0.001	0.0003		11.0	0.314	0.0771	-0.0607	-0.0002	-0.003	0.0003
	6.9	0.304	0.0541	-0.0619	-0.0001	-0.002	0.0003		13.2	0.372	0.1017	-0.0701	-0.0001	-0.003	0.0003
	9.2	0.401	0.0811	-0.0814	0.0000	-0.003	0.0004		15.5	0.430	0.1311	-0.0794	0.0000	-0.004	0.0003
	11.5	0.488	0.1137	-0.0974	-0.0003	-0.004	0.0003								
	13.8	0.577	0.1546	-0.1150	0.0000	-0.004	0.0002								
	16.1	0.663	0.2022	-0.1315	0.0000	-0.005	0.0001								

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TABLE I.- AERODYNAMIC CHARACTERISTICS THROUGH ANGLE-OF-ATTACK
 RANGE AT $\beta = 0^\circ$ - Continued
 (b) Twisted and cambered wing configuration

M	α , deg	C_L	C_D	C_m	C_l	C_Y	C_n	M	α , deg	C_L	C_D	C_m	C_l	C_Y	C_n
0.70	-0.4	-0.274	0.0366	0.0403	-0.0006	-0.002	0.0008	1.70	-0.4	-0.182	0.0394	0.0406	-0.0003	-0.003	0.0006
	-2.4	-.154	.0208	.0289	-.0004	-.001	.0007		-2.2	-.094	.0274	.0243	-.0003	-.002	.0005
	-0.1	-.046	.0139	.0181	-.0002	-.001	.0004		0.0	-.003	.0224	.0064	-.0003	-.002	.0003
	0.9	.008	.0131	.0133	-.0002	-.001	.0002		1.1	.043	.0225	-.0025	-.0003	-.001	.0002
	2.0	.057	.0132	.0089	-.0001	-.001	.0002		2.2	.085	.0238	-.0106	-.0003	-.001	.0001
	3.1	.105	.0142	.0054	.0000	.000	.0000		3.3	.131	.0271	-.0197	-.0003	-.001	.0001
	4.2	.154	.0165	.0010	.0001	-.001	.0000		4.5	.175	.0321	-.0284	-.0003	-.001	-.0001
	6.5	.272	.0316	-.0076	.0001	-.001	-.0002		6.7	.258	.0466	-.0447	-.0002	-.001	-.0001
	8.8	.391	.0571	-.0150	.0001	-.002	-.0004		9.0	.339	.0681	-.0607	-.0001	-.002	-.0001
	11.0	.489	.0892	-.0163	.0001	-.003	-.0006		11.3	.418	.0961	-.0759	.0000	-.002	-.0003
	13.1	.566	.1248	-.0286	.0001	-.003	-.0008		13.4	.491	.1293	-.0901	.0001	-.003	-.0003
	15.5	.716	.1907	-.0358	.0003	-.004	-.0010		15.8	.562	.1680	-.1017	.0000	-.003	-.0005
	17.8	.821	.2558	-.0470	.0002	-.005	-.0012		18.0	.622	.2091	-.1142	-.0001	-.003	-.0008
									20.2	.692	.2589	-.1226	-.0001	-.004	-.0009
0.90	-4.6	-.314	.0417	.0642	-.0007	-.003	.0009	2.00	-4.1	-.130	.0324	.0256	-.0002	-.002	.0003
	-2.3	-.176	.0225	.0435	-.0004	-.003	.0008		-1.9	-.057	.0237	.0127	-.0003	-.001	.0002
	0.0	-.050	.0140	.0245	-.0002	-.002	.0005		0.2	.016	.0207	-.0007	-.0003	-.001	.0001
	1.1	.010	.0132	.0170	-.0001	-.002	.0005		1.3	.055	.0214	-.0078	-.0003	-.001	.0000
	2.2	.062	.0135	.0115	.0000	-.002	.0003		2.3	.090	.0231	-.0144	-.0003	-.001	.0000
	3.4	.122	.0153	.0049	.0000	-.002	.0002		3.5	.127	.0264	-.0211	-.0002	-.001	-.0001
	4.6	.190	.0201	-.0029	.0001	-.002	.0000		4.6	.162	.0311	-.0276	-.0002	.000	-.0002
	6.9	.322	.0406	-.0151	.0002	-.002	-.0002		6.7	.229	.0436	-.0397	-.0002	-.001	-.0002
									8.9	.295	.0615	-.0514	-.0001	-.001	-.0002
									11.1	.356	.0835	-.0625	-.0001	-.002	-.0003
1.20	-2.0	-.131	.0294	.0484	-.0002	-.002	.0002	2.20	-1.7	-.054	.0228	.0090	-.0004	-.001	.0001
	0.2	-.008	.0234	.0226	-.0001	-.002	.0000		0.4	.010	.0203	-.0017	-.0003	.000	.0001
	1.4	.051	.0232	.0105	.0000	-.001	-.0002		1.5	.044	.0208	-.0077	-.0004	.000	.0000
	2.5	.110	.0251	-.0016	.0001	.000	-.0004		2.5	.074	.0223	-.0129	-.0004	-.001	.0000
	3.8	.178	.0290	-.0154	.0001	.000	-.0005		3.6	.108	.0254	-.0188	-.0003	.000	-.0001
	4.9	.243	.0356	-.0287	.0002	.000	-.0006		4.7	.137	.0293	-.0238	-.0003	-.001	.0000
	7.3	.368	.0570	-.0532	.0006	-.001	-.0006		6.8	.200	.0408	-.0347	-.0002	-.001	-.0001
	9.6	.487	.0898	-.0750	-.0001	-.002	-.0003		9.0	.258	.0570	-.0445	-.0002	-.001	-.0001
	11.9	.599	.1314	-.0986	-.0001	-.002	-.0007		11.1	.316	.0763	-.0548	-.0002	-.002	-.0002
	14.2	.709	.1824	-.1231	.0000	-.002	-.0011		13.2	.368	.0991	-.0630	-.0001	-.003	-.0002
1.50	16.6	.815	.2411	-.1423	-.0004	.0004	-.0022	15.4	.423	.1273	-.0707	.0000	-.003	-.0003	
	18.9	.901	.3079	-.1482	.0003	-.004	-.0012		17.6	.479	.1600	-.0772	-.0001	-.004	-.0005
									19.7	.538	.1991	-.0831	.0000	-.005	-.0005
	-4.5	-.207	.0420	.0499	-.0004	-.003	.0006								
	-2.3	-.105	.0285	.0294	-.0004	-.002	.0004								
	0.0	-.003	.0233	.0079	-.0003	-.001	.0002								
	1.1	.047	.0233	-.0018	-.0002	-.001	.0002								
	2.2	.101	.0250	-.0128	-.0002	-.001	.0000								
	3.5	.154	.0286	-.0235	-.0002	.000	-.0001								
	4.6	.204	.0343	-.0339	-.0002	.000	-.0001								
	6.9	.302	.0512	-.0540	-.0001	-.001	-.0002								
	9.2	.404	.0778	-.0745	.0000	-.001	-.0004								
	11.5	.487	.1093	-.0895	.0000	-.002	-.0005								
	13.7	.573	.1487	-.1047	.0000	-.002	-.0005								
	15.9	.649	.1923	-.1192	.0000	-.002	-.0007								
	18.3	.731	.2463	-.1343	.0000	-.003	-.0008								
	20.6	.805	.3052	-.1456	.0000	-.004	-.0011								

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TABLE I.- AERODYNAMIC CHARACTERISTICS THROUGH ANGLE-OF-ATTACK
RANGE AT $\beta = 0^\circ$ - Concluded
(c) Twisted and cambered wing configuration with modified leading edge

M	α , deg	C_L	C_D	C_m	C_{L_i}	C_Y	C_n	M	α , deg	C_L	C_D	C_m	C_{L_i}	C_Y	C_n
0.70	-0.7	-0.311	0.0478	0.0445	-0.0007	-0.003	0.0009	1.70	-0.5	-0.193	0.0451	0.0424	-0.0004	-0.003	0.0005
	-2.5	-0.189	.0285	.0335	-0.0006	-0.002	.0007		-2.3	-0.109	.0319	.0270	-0.0004	-0.002	.0003
	-0.4	-0.081	.0182	.0238	-0.0005	-0.001	.0004		0.0	-0.018	.0252	.0095	-0.0004	-0.001	.0002
	0.9	-0.008	.0153	.0167	-0.0002	-0.001	.0003		1.1	.029	.0244	.0006	-0.0004	-0.001	.0001
	1.9	.040	.0143	.0119	-0.0002	-0.001	.0002		2.2	.073	.0251	-.0082	-0.0004	-0.001	.0001
	3.1	.097	.0145	.0065	.0000	-0.001	.0001		3.4	.119	.0279	-.0170	-0.0003	-0.001	.0000
	4.3	.151	.0156	.0018	.0001	-0.001	.0000		4.6	.165	.0325	-.0261	-0.0002	-0.001	-.0001
	6.4	.249	.0218	-.0055	.0003	-0.001	-.0002		6.7	.244	.0449	-.0414	-0.0002	-0.001	-.0001
	8.7	.365	.0417	-.0144	.0005	-0.004	.0002		8.9	.325	.0642	-.0571	-0.0001	-0.002	-.0001
	11.0	.493	.0803	-.0202	.0006	-0.003	-.0005		11.2	.405	.0899	-.0722	.0000	-0.002	-.0002
	13.2	.592	.1212	-.0269	.0004	-0.003	-.0008		13.5	.483	.1216	-.0870	.0000	-0.003	-.0003
	15.6	.715	.1795	-.0360	.0005	-0.004	-.0011		15.8	.560	.1613	-.1008	.0001	-0.003	-.0005
	17.8	.825	.2446	-.0458	.0005	-0.006	-.0012		17.9	.630	.2044	-.1125	.0001	-0.003	-.0007
									20.2	.697	.2535	-.1215	.0003	-0.004	-.0009
0.90	-4.7	-0.355	.0542	.0742	-0.0008	-0.004	.0011	2.00	-4.1	-0.141	.0376	.0270	-0.0003	-0.002	.0003
	-2.3	-0.205	.0299	.0497	-0.0007	-0.003	.0007		-1.9	-0.069	.0277	.0146	-0.0004	-0.001	.0002
	0.0	-0.076	.0181	.0313	-0.0004	-0.002	.0005		0.1	.003	.0233	.0015	-0.0003	-0.001	.0001
	1.1	-.012	.0152	.0224	-0.0002	-0.002	.0005		1.3	.039	.0233	-.0046	-0.0003	.000	.0000
	2.2	.052	.0141	.0138	-0.0001	-0.002	.0003		2.3	.077	.0245	-.0119	-0.0003	-0.001	.0000
	3.4	.111	.0147	.0061	.0001	-0.002	.0002		3.4	.112	.0270	-.0183	-0.0002	-0.001	-.0001
	4.5	.172	.0166	-.0006	.0001	-0.002	.0000		4.6	.151	.0313	-.0252	-0.0002	.000	-.0001
	6.9	.298	.0282	-.0123	.0006	-0.002	-.0001		6.7	.217	.0424	-.0373	-0.0002	.000	-.0002
	9.3	.439	.0624	-.0264	.0003	-0.003	-.0003		8.9	.284	.0589	-.0493	-0.0001	-0.001	-.0001
									11.0	.346	.0796	-.0603	-0.0001	-0.002	-.0002
1.20	-4.4	-0.290	.0550	.0811	-0.0006	-0.003	.0005	2.20	-3.9	-0.132	.0361	.0217	-0.0005	-0.002	.0002
	-2.1	-0.158	.0353	.0539	-0.0006	-0.002	.0000		-1.8	-0.069	.0275	.0116	-0.0004	-0.001	.0002
	0.2	-.027	.0260	.0262	-0.0004	-0.002	.0000		0.3	-.002	.0237	.0007	-0.0004	.000	.0001
	1.3	.033	.0245	.0145	-0.0002	-0.001	-.0002		1.5	.033	.0236	-.0051	-0.0003	.000	.0000
	2.6	.103	.0253	-.0004	-0.0001	.000	-.0004		2.5	.063	.0242	-.0106	-0.0003	.000	-.0001
	3.7	.162	.0279	-.0125	.0001	.000	-.0005		3.5	.094	.0262	-.0158	-0.0002	-0.001	-.0001
	4.8	.225	.0329	-.0249	.0003	.000	-.0006		4.7	.129	.0301	-.0218	-0.0003	.000	-.0002
	7.2	.354	.0514	-.0510	.0001	.000	-.0008		6.8	.189	.0403	-.0322	-0.0003	.000	-.0002
	9.6	.484	.0820	-.0769	-0.0001	-0.001	-.0010		8.9	.247	.0547	-.0423	-0.0002	-0.001	-.0002
	12.0	.597	.1237	-.0982	.0008	-0.002	-.0007		11.1	.306	.0733	-.0522	-0.0002	-0.001	-.0002
	14.3	.707	.1739	-.1206	.0004	-0.002	-.0010		13.1	.362	.0949	-.0611	-0.0001	-0.002	-.0002
	16.6	.822	.2331	-.1491	.0003	-0.001	-.0017		15.3	.421	.1225	-.0695	-0.0001	-0.003	-.0002
	19.0	.904	.2984	-.1473	.0005	-0.004	-.0012		17.5	.479	.1547	-.0765	.0000	-0.003	-.0005
	21.3	1.002	.3767	-.1624	.0006	-0.003	-.0024		19.7	.538	.1930	-.0824	.0001	-0.005	-.0006
1.50	-4.6	-0.222	.0485	.0533	-0.0006	-0.003	.0005								
	-2.3	-0.118	.0330	.0323	-0.0005	-0.002	.0003								
	-0.1	-0.019	.0259	.0121	-0.0004	-0.001	.0002								
	1.1	.035	.0250	.0010	-0.0003	.000	.0000								
	2.1	.083	.0256	-.0090	-0.0003	.000	-.0001								
	3.4	.138	.0285	-.0205	-0.0003	.000	-.0003								
	4.6	.189	.0331	-.0309	-0.0002	.000	-.0004								
	6.9	.292	.0490	-.0515	-0.0001	-0.001	-.0003								
	9.1	.384	.0709	-.0694	-0.0001	-0.001	-.0004								
	11.5	.481	.1028	-.0881	.0002	-0.002	-.0004								
	13.7	.567	.1399	-.1038	-0.0001	-0.002	-.0005								
	16.0	.651	.1858	-.1189	.0001	-0.002	-.0006								
	18.2	.729	.2366	-.1333	.0002	-0.003	-.0008								
	20.5	.806	.2955	-.1453	.0004	-0.004	-.0010								

TABLE II.- AERODYNAMIC CHARACTERISTICS THROUGH ANGLE-OF-ATTACK
RANGE AT $\beta = 5^\circ$
(a) Symmetrical wing configuration

M	α , deg	C_L	C_D	C_m	C_l	C_Y	C_n	M	α , deg	C_L	C_D	C_m	C_l	C_Y	C_n
0.70	-04.7	-0.253	0.0335	0.0224	-0.0026	-0.066	0.0151	1.70	-04.6	-0.189	0.0436	0.0339	-0.0063	-0.069	0.0138
	-2.4	-.137	.0211	.0123	-.0033	-.064	.0149		-2.3	-.099	.0315	.0177	-.0059	-.063	.0132
	-0.1	-.028	.0167	.0023	-.0049	-.064	.0149		0.0	-.002	.0264	-.0006	-.0064	-.058	.0121
	0.9	.023	.0164	-.0018	-.0058	-.063	.0147		1.0	.041	.0266	-.0093	-.0066	-.056	.0116
	2.0	.074	.0172	-.0064	-.0064	-.063	.0145		2.2	.088	.0286	-.0183	-.0066	-.055	.0111
	3.1	.129	.0200	-.0110	-.0069	-.064	.0143		3.3	.131	.0321	-.0266	-.0065	-.054	.0106
	4.3	.189	.0256	-.0163	-.0077	-.064	.0142		4.5	.174	.0375	-.0351	-.0063	-.053	.0100
	6.5	.305	.0432	-.0247	-.0081	-.066	.0139		6.7	.258	.0527	-.0515	-.0062	-.053	.0088
	8.8	.427	.0714	-.0322	-.0085	-.067	.0131		8.9	.338	.0741	-.0674	-.0062	-.052	.0073
	10.9	.520	.1042	-.0355	-.0087	-.068	.0120		11.1	.416	.1014	-.0832	-.0066	-.052	.0056
0.90	-4.7	-.285	.0384	.0380	-.0028	-.073	.0172	2.00	13.4	.491	.1346	-.0978	-.0068	-.051	.0034
	-2.3	-.149	.0225	.0199	-.0031	-.070	.0172		15.6	.560	.1717	-.1101	-.0074	-.051	.0016
	0.0	-.027	.0176	.0044	-.0050	-.069	.0172		17.8	.628	.2151	-.1221	-.0077	-.051	.0000
	1.1	.031	.0172	-.0021	-.0060	-.069	.0170		-4.2	-.136	.0370	.0193	-.0065	-.063	.0111
	2.3	.094	.0191	-.0099	-.0067	-.069	.0168		-2.0	-.060	.0278	.0070	-.0058	-.056	.0104
	3.5	.161	.0235	-.0179	-.0075	-.069	.0167		0.1	.015	.0246	-.0064	-.0051	-.052	.0094
	4.6	.231	.0316	-.0255	-.0079	-.069	.0167		1.2	.053	.0252	-.0133	-.0048	-.050	.0089
	7.0	.368	.0560	-.0421	-.0083	-.072	.0166		2.4	.090	.0273	-.0201	-.0047	-.049	.0084
1.20	-4.4	-.265	.0482	.0614	-.0052	-.075	.0187	2.20	3.5	.127	.0309	-.0269	-.0046	-.049	.0077
	-2.1	-.134	.0330	.0347	-.0070	-.068	.0172		4.7	.164	.0359	-.0338	-.0046	-.048	.0071
	0.2	-.006	.0274	.0087	-.0092	-.064	.0162		6.7	.228	.0481	-.0456	-.0044	-.047	.0059
	1.4	.059	.0278	-.0045	-.0101	-.063	.0159		8.9	.295	.0661	-.0580	-.0045	-.047	.0043
	2.6	.126	.0308	-.0181	-.0109	-.062	.0157		11.0	.355	.0879	-.0687	-.0051	-.047	.0028
	3.7	.187	.0361	-.0304	-.0116	-.061	.0154		13.2	.416	.1153	-.0794	-.0058	-.047	.0009
	4.9	.254	.0443	-.0440	-.0122	-.061	.0152		15.3	.475	.1455	-.0899	-.0065	-.046	-.0005
	7.2	.377	.0684	-.0678	-.0117	-.061	.0146		17.5	.530	.1798	-.0968	-.0070	-.046	-.0017
	9.6	.499	.1022	-.0910	-.0114	-.064	.0157		19.6	.592	.2215	-.1037	-.0075	-.045	-.0021
	11.9	.614	.1458	-.1142	-.0107	-.067	.0155		-3.9	-.124	.0354	.0137	-.0063	-.061	.0097
1.50	-4.7	-.217	.0461	.0428	-.0064	-.071	.0156	2.40	-1.8	-.057	.0273	.0033	-.0053	-.054	.0092
	-2.3	-.109	.0324	.0216	-.0064	-.065	.0149		0.4	.011	.0242	-.0074	-.0044	-.049	.0080
	0.0	-.005	.0271	.0009	-.0073	-.060	.0140		1.4	.041	.0248	-.0130	-.0041	-.048	.0075
	1.1	.050	.0273	-.0103	-.0078	-.059	.0135		2.4	.072	.0266	-.0183	-.0039	-.046	.0069
	2.3	.102	.0296	-.0207	-.0081	-.058	.0132		3.5	.106	.0295	-.0238	-.0037	-.046	.0063
	3.4	.154	.0339	-.0312	-.0083	-.057	.0128		4.7	.139	.0338	-.0297	-.0036	-.045	.0056
	4.5	.204	.0401	-.0412	-.0084	-.056	.0124		6.9	.202	.0458	-.0407	-.0037	-.044	.0043
	6.8	.302	.0581	-.0610	-.0084	-.056	.0114		8.9	.256	.0603	-.0502	-.0038	-.043	.0029
	9.1	.404	.0851	-.0818	-.0089	-.056	.0102		11.0	.311	.0800	-.0596	-.0044	-.043	.0011
	11.4	.490	.1170	-.0991	-.0088	-.055	.0087		13.2	.366	.1031	-.0689	-.0052	-.044	-.0004
	13.7	.578	.1569	-.1161	-.0089	-.055	.0070		15.3	.424	.1319	-.0784	-.0062	-.044	-.0016
	15.9	.660	.2020	-.1309	-.0082	-.056	.0054		17.5	.482	.1657	-.0861	-.0070	-.043	-.0023
									19.6	.537	.2019	-.0908	-.0076	-.041	-.0025

TABLE II.- AERODYNAMIC CHARACTERISTICS THROUGH ANGLE-OF-ATTACK
 RANGE AT $\beta = 5^\circ$ - Concluded
 (b) Twisted and cambered wing configuration with modified leading edge

M	α , deg	C_L	C_D	C_m	C_l	C_Y	C_n	M	α , deg	C_L	C_D	C_m	C_l	C_Y	C_n
0.70	-0.8	-0.328	0.0534	0.0443	-0.0021	-0.072	0.0165	1.70	-0.5	-0.202	0.0513	0.0440	-0.0062	-0.072	0.0155
	-2.5	-.199	.0329	.0328	-.0029	-.069	.0161		-2.3	-.118	.0379	.0286	-.0055	-.066	.0149
	-0.2	-.080	.0219	.0217	-.0040	-.067	.0159		0.0	-.027	.0302	.0108	-.0053	-.060	.0135
	0.8	-.027	.0196	.0167	-.0044	-.066	.0157		0.9	.013	.0294	.0030	-.0051	-.059	.0131
	1.9	.030	.0184	.0115	-.0052	-.065	.0153		2.0	.053	.0296	-.0043	-.0049	-.059	.0126
	3.1	.085	.0184	.0062	-.0061	-.064	.0148		3.1	.100	.0317	-.0138	-.0046	-.058	.0121
	4.2	.139	.0196	.0017	-.0070	-.064	.0145		4.3	.145	.0356	-.0224	-.0045	-.057	.0115
	6.3	.234	.0260	-.0054	-.0082	-.065	.0141		6.4	.225	.0472	-.0380	-.0044	-.056	.0101
	10.9	.477	.0808	-.0205	-.0090	-.066	.0122		8.7	.304	.0648	-.0534	-.0042	-.056	.0085
	13.1	.577	.1217	-.0248	-.0085	-.068	.0117		10.8	.382	.0881	-.0683	-.0038	-.056	.0067
	15.4	.699	.1776	-.0345	-.0087	-.070	.0107		13.0	.457	.1174	-.0824	-.0040	-.055	.0045
	17.6	.807	.2412	-.0444	-.0088	-.070	.0093		15.2	.534	.1538	-.0973	-.0046	-.053	.0022
									17.4	.600	.1933	-.1085	-.0057	-.051	.0005
									19.6	.666	.2385	-.1178	-.0068	-.049	-.0015
0.90	-4.8	-.371	.0628	.0777	-.0028	-.081	.0198	2.00	-4.2	-.154	.0445	.0280	-.0057	-.067	.0130
	-2.3	-.218	.0369	.0535	-.0037	-.077	.0195		-2.0	-.081	.0335	.0157	-.0047	-.060	.0122
	0.0	-.084	.0244	.0319	-.0045	-.075	.0193		0.1	-.006	.0284	.0024	-.0038	-.056	.0112
	1.1	-.018	.0214	.0220	-.0050	-.075	.0191		1.2	.027	.0282	-.0032	-.0034	-.055	.0107
	2.2	.045	.0204	.0128	-.0057	-.074	.0187		2.2	.065	.0291	-.0101	-.0030	-.054	.0101
	3.3	.109	.0208	.0040	-.0067	-.072	.0181		3.4	.102	.0312	-.0166	-.0027	-.053	.0093
	4.5	.172	.0233	-.0039	-.0076	-.073	.0179		4.4	.137	.0347	-.0228	-.0026	-.053	.0086
	6.8	.293	.0354	-.0163	-.0092	-.072	.0168		6.6	.205	.0456	-.0354	-.0026	-.052	.0071
	9.2	.435	.0668	-.0303	-.0091	-.073	.0160		8.8	.271	.0610	-.0473	-.0028	-.051	.0055
	11.4	.536	.1037	-.0363	-.0081	-.072	.0144		10.9	.337	.0814	-.0589	-.0032	-.051	.0036
	13.8	.672	.1592	-.0570	-.0079	-.073	.0126		13.1	.401	.1060	-.0694	-.0038	-.050	.0015
	16.1	.792	.2232	-.0781	-.0080	-.072	.0102		15.2	.462	.1357	-.0795	-.0046	-.049	-.0001
									17.4	.523	.1698	-.0882	-.0054	-.047	-.0015
									19.6	.587	.2107	-.0942	-.0063	-.044	-.0021
1.20	-4.5	-.308	.0617	.0838	-.0060	-.077	.0194	2.20	-3.9	-.143	.0424	.0225	-.0051	-.064	.0112
	-2.1	-.169	.0407	.0552	-.0071	-.070	.0178		-1.8	-.079	.0327	.0125	-.0040	-.058	.0105
	0.2	-.040	.0306	.0291	-.0083	-.065	.0169		0.2	-.016	.0281	.0023	-.0030	-.053	.0095
	1.3	.019	.0290	.0166	-.0089	-.063	.0164		1.3	.018	.0277	-.0034	-.0025	-.052	.0089
	2.5	.085	.0295	.0028	-.0099	-.062	.0159		2.4	.050	.0286	-.0087	-.0021	-.051	.0083
	3.7	.147	.0322	-.0096	-.0107	-.061	.0156		3.5	.086	.0307	-.0145	-.0019	-.050	.0076
	4.8	.210	.0369	-.0221	-.0111	-.061	.0154		4.6	.117	.0339	-.0199	-.0017	-.049	.0070
	7.2	.335	.0544	-.0465	-.0109	-.063	.0152		6.7	.176	.0431	-.0298	-.0016	-.049	.0055
	9.5	.460	.0838	-.0712	-.0115	-.061	.0137		8.9	.237	.0570	-.0402	-.0020	-.048	.0038
	11.9	.577	.1234	-.0938	-.0115	-.061	.0126		11.0	.297	.0751	-.0502	-.0027	-.047	.0021
	14.1	.681	.1704	-.1148	-.0101	-.062	.0124		13.1	.355	.0968	-.0597	-.0036	-.046	.0001
									15.2	.415	.1239	-.0692	-.0046	-.045	-.0013
									17.4	.473	.1558	-.0763	-.0055	-.044	-.0019
									19.5	.534	.1932	-.0816	-.0064	-.042	-.0023
1.50	-4.5	-.231	.0548	.0547	-.0071	-.073	.0168								
	-2.3	-.131	.0390	.0350	-.0061	-.067	.0160								
	0.0	-.030	.0308	.0144	-.0059	-.062	.0150								
	0.9	.017	.0294	.0050	-.0061	-.061	.0146								
	2.1	.068	.0301	-.0052	-.0061	-.060	.0143								
	3.2	.120	.0326	-.0160	-.0062	-.060	.0139								
	4.4	.170	.0367	-.0259	-.0063	-.059	.0135								
	6.5	.262	.0498	-.0446	-.0063	-.059	.0124								
	8.7	.356	.0702	-.0630	-.0056	-.059	.0111								
	11.0	.448	.0988	-.0807	-.0058	-.058	.0094								
	13.2	.537	.1338	-.0987	-.0062	-.057	.0074								
	15.4	.618	.1747	-.1135	-.0066	-.055	.0054								
	17.6	.698	.2228	-.1278	-.0070	-.053	.0036								
	19.8	.776	.2788	-.1414	-.0077	-.053	.0020								

TABLE III.- AERODYNAMIC CHARACTERISTICS THROUGH ANGLE-OF-SIDESLIP
RANGE AT $\alpha = 0^\circ$

(a) Symmetrical wing configuration

M	β , deg	C_L	C_D	C_m	C_l	C_Y	C_n	M	β , deg	C_L	C_D	C_m	C_l	C_Y	C_n
0.70	-03.8	-0.031	0.0154	0.0011	0.0012	0.050	-0.0106	1.70	-03.9	-0.003	0.0247	-0.0014	0.0038	0.044	-0.0092
	0.1	-0.032	.0135	.0029	-.0019	.001	.0002		0.0	-.004	.0219	-.0009	-.0010	.001	.0001
	1.1	-0.032	.0133	.0027	-.0027	-.011	.0027		0.9	-.004	.0220	-.0009	-.0020	-.010	.0023
	2.1	-0.032	.0137	.0021	-.0034	-.023	.0053		2.0	-.004	.0225	-.0010	-.0033	-.022	.0050
	3.1	-0.030	.0144	.0015	-.0041	-.036	.0082		3.0	-.005	.0235	-.0009	-.0045	-.034	.0076
	4.0	-.029	.0155	.0007	-.0051	-.049	.0114		3.8	-.006	.0247	-.0010	-.0056	-.044	.0098
	6.0	-.028	.0199	-.0004	-.0073	-.082	.0194		5.9	-.008	.0288	-.0010	-.0079	-.070	.0147
	8.0	-.028	.0266	-.0010	-.0095	-.115	.0272		7.8	-.012	.0346	-.0008	-.0096	-.095	.0184
0.90	-4.0	-.038	.0166	.0051	.0015	.057	-.0136	2.00	-4.1	-.003	.0242	-.0034	.0039	.049	-.0084
	0.0	-.041	.0135	.0074	-.0017	.004	-.0007		-0.1	-.002	.0204	-.0029	.0000	.008	-.0013
	0.9	-.041	.0135	.0075	-.0022	-.008	.0020		0.7	-.003	.0204	-.0028	-.0011	-.002	.0006
	1.9	-.041	.0142	.0067	-.0029	-.021	.0050		1.8	-.004	.0209	-.0026	-.0022	-.013	.0027
	2.9	-.040	.0147	.0058	-.0037	-.035	.0083		2.8	-.004	.0217	-.0026	-.0032	-.024	.0047
	3.8	-.039	.0157	.0051	-.0047	-.049	.0120		3.7	-.005	.0228	-.0026	-.0040	-.034	.0066
	5.8	-.037	.0204	.0029	-.0065	-.083	.0205		5.7	-.007	.0264	-.0028	-.0057	-.057	.0101
	7.7	-.037	.0266	.0013	-.0067	-.110	.0254		7.6	-.010	.0319	-.0033	-.0072	-.082	.0134
1.20	-4.2	-.023	.0267	.0112	.0062	.053	-.0136	2.20	-4.3	-.003	.0235	-.0045	.0035	.046	-.0072
	-0.1	-.027	.0233	.0138	-.0011	.001	.0002		-0.3	-.003	.0198	-.0040	.0000	.007	-.0010
	0.7	-.025	.0236	.0125	-.0025	-.009	.0026		0.6	-.003	.0199	-.0040	-.0010	-.003	.0006
	1.7	-.026	.0237	.0128	-.0043	-.022	.0064		1.6	-.004	.0203	-.0038	-.0019	-.013	.0025
	2.7	-.026	.0245	.0130	-.0062	-.036	.0103		2.6	-.005	.0213	-.0037	-.0028	-.023	.0041
	3.6	-.027	.0257	.0132	-.0080	-.050	.0139		3.5	-.005	.0226	-.0039	-.0038	-.035	.0059
	5.6	-.027	.0296	.0116	-.0118	-.079	.0216		5.5	-.008	.0263	-.0043	-.0051	-.056	.0087
	7.6	-.030	.0358	.0122	-.0150	-.110	.0291		7.4	-.011	.0317	-.0048	-.0063	-.079	.0108
1.50	-4.0	-.006	.0259	.0018	.0049	.049	-.0112								
	0.0	-.007	.0229	.0025	-.0009	.002	-.0005								
	0.9	-.007	.0230	.0025	-.0020	-.009	.0019								
	2.0	-.008	.0236	.0027	-.0035	-.021	.0048								
	2.9	-.009	.0244	.0027	-.0048	-.032	.0074								
	3.9	-.010	.0256	.0027	-.0062	-.045	.0103								
	5.9	-.013	.0295	.0031	-.0090	-.072	.0161								
	7.8	-.016	.0364	.0037	-.0112	-.099	.0209								

TABLE III.- AERODYNAMIC CHARACTERISTICS THROUGH ANGLE-OF-SIDESLIP
 RANGE AT $\alpha = 0^\circ$ - Concluded
 (b) Twisted and cambered wing configuration with modified leading edge

M	β , deg	C_L	C_D	C_m	C_l	C_Y	C_n	M	β , deg	C_L	C_D	C_m	C_l	C_Y	C_n
0.70	-03.8	-0.073	0.0201	0.0193	0.0006	0.0514	-0.0122	1.70	-03.9	-0.022	0.0289	0.0096	0.0033	0.051	-0.0119
	0.0	-0.076	.0182	.0218	-.0019	.003	-.0007		0.0	-.024	.0256	.0102	-.0005	.004	-.0012
	1.0	-0.077	.0182	.0219	-.0024	-.009	.0020		0.9	-.024	.0258	.0103	-.0015	-.008	.0016
	2.0	-0.077	.0187	.0214	-.0030	-.022	.0048		1.9	-.025	.0263	.0102	-.0025	-.021	.0046
	3.0	-0.077	.0192	.0209	-.0036	-.035	.0077		2.9	-.025	.0272	.0103	-.0035	-.033	.0074
	4.0	-0.076	.0205	.0202	-.0044	-.049	.0113		3.9	-.027	.0287	.0103	-.0045	-.046	.0104
	6.0	-0.075	.0249	.0189	-.0063	-.082	.0196		5.9	-.030	.0332	.0105	-.0063	-.074	.0162
	8.0	-0.075	.0317	.0180	-.0083	-.115	.0278		7.7	-.032	.0392	.0107	-.0075	-.099	.0206
0.90	-4.1	-0.090	.0219	.0298	.0009	.062	-.0157	2.00	-4.1	-.020	.0286	.0056	.0029	.054	-.0109
	-0.1	-0.096	.0190	.0333	-.0018	.006	-.0017		-0.2	-.020	.0243	.0062	.0002	.011	-.0026
	0.8	-0.095	.0187	.0323	-.0022	-.006	.0012		0.7	-.021	.0242	.0064	-.0006	-.001	.0000
	1.8	-0.096	.0195	.0327	-.0027	-.020	.0043		1.7	-.022	.0248	.0065	-.0015	-.013	.0027
	2.8	-0.095	.0199	.0318	-.0033	-.034	.0077		2.7	-.023	.0258	.0066	-.0023	-.025	.0051
	3.8	-0.095	.0212	.0312	-.0042	-.049	.0115		3.7	-.023	.0271	.0066	-.0030	-.037	.0074
	5.8	-0.096	.0268	.0306	-.0061	-.085	.0212		5.7	-.027	.0311	.0065	-.0042	-.063	.0120
	7.6	-0.093	.0320	.0271	-.0063	-.112	.0265		7.6	-.030	.0366	.0066	-.0051	-.086	.0155
1.20	-4.2	-.049	.0300	.0295	.0057	.057	-.0152	2.20	-4.4	-.020	.0278	.0037	.0023	.052	-.0095
	-0.2	-.052	.0265	.0324	-.0010	.003	-.0007		0.6	-.022	.0240	.0044	-.0007	-.003	.0004
	0.7	-.054	.0266	.0328	-.0026	-.010	.0027		1.6	-.022	.0244	.0046	-.0014	-.014	.0026
	1.6	-.052	.0272	.0305	-.0039	-.020	.0050		2.5	-.023	.0254	.0048	-.0020	-.025	.0047
	2.6	-.053	.0278	.0307	-.0054	-.033	.0086		3.5	-.025	.0269	.0048	-.0026	-.037	.0067
	3.6	-.055	.0292	.0308	-.0072	-.049	.0132		5.5	-.028	.0310	.0047	-.0035	-.061	.0102
	5.6	-.059	.0336	.0317	-.0109	-.082	.0224		7.4	-.031	.0366	.0045	-.0041	-.083	.0127
	7.5	-.064	.0398	.0325	-.0138	-.112	.0301								
1.50	-3.9	-.025	.0294	.0140	.0040	.053	-.0132								
	0.0	-.027	.0262	.0151	-.0005	.004	-.0014								
	0.9	-.028	.0263	.0152	-.0015	-.008	.0014								
	1.9	-.028	.0268	.0154	-.0026	-.021	.0044								
	2.9	-.029	.0278	.0155	-.0038	-.034	.0077								
	3.9	-.031	.0291	.0157	-.0050	-.047	.0109								
	5.9	-.034	.0333	.0163	-.0073	-.075	.0173								
	7.7	-.038	.0393	.0171	-.0092	-.101	.0227								

TABLE IV.- AERODYNAMIC CHARACTERISTICS THROUGH ANGLE-OF-SIDESLIP
 RANGE AT $\alpha = 5^\circ$
 (a) Symmetrical wing configuration

M	β , deg	C_L	C_D	C_m	C_l	C_Y	C_n	M	β , deg	C_L	C_D	C_m	C_l	C_Y	C_n
0.70	-07.7	0.245	0.0406	-0.0242	0.0096	0.100	-0.0219	1.70	-07.7	0.216	0.0500	-0.0432	0.0081	0.078	-0.0125
	-5.7	.246	.0351	-.0231	.0064	.069	-.0156		-5.8	.220	.0458	-.0440	.0061	.056	-.0101
	-3.8	.247	.0318	-.0227	.0029	.040	-.0090		-3.8	.223	.0429	-.0444	.0039	.035	-.0072
	-2.8	.247	.0309	-.0225	.0013	.027	-.0060		-2.9	.224	.0419	-.0446	.0027	.025	-.0054
	-1.8	.248	.0305	-.0223	-.0002	.016	-.0036		-1.9	.225	.0411	-.0446	.0013	.015	-.0033
	-0.8	.247	.0300	-.0218	-.0016	.003	-.0009		-0.9	.225	.0409	-.0446	.0000	.005	-.0013
	0.0	.248	.0301	-.0219	-.0029	-.007	.0014		0.0	.224	.0406	-.0446	-.0014	-.005	.0008
	1.1	.246	.0303	-.0217	-.0046	-.016	.0035		0.9	.224	.0408	-.0446	-.0027	-.015	.0027
	2.0	.246	.0306	-.0221	-.0059	-.027	.0058		2.0	.224	.0414	-.0446	-.0041	-.026	.0050
	3.0	.246	.0313	-.0224	-.0075	-.042	.0091		2.9	.223	.0421	-.0443	-.0053	-.037	.0070
	4.0	.249	.0331	-.0233	-.0090	-.061	.0137		3.9	.222	.0440	-.0442	-.0064	-.049	.0091
	6.0	.247	.0377	-.0233	-.0124	-.092	.0206		5.9	.217	.0471	-.0434	-.0085	-.073	.0121
	7.9	.244	.0440	-.0241	-.0148	-.125	.0271		7.8	.210	.0524	-.0424	-.0103	-.097	.0145
0.90	-7.9	.277	.0485	-.0351	.0087	.106	-.0234	2.00	-8.0	.169	.0446	-.0361	.0055	.076	-.0079
	-5.9	.277	.0415	-.0329	.0071	.077	-.0190		-6.0	.176	.0407	-.0368	.0043	.056	-.0071
	-3.9	.282	.0385	-.0333	.0042	.048	-.0122		-4.1	.178	.0377	-.0370	.0030	.037	-.0055
	-3.0	.277	.0360	-.0316	.0022	.032	-.0079		-3.1	.179	.0366	-.0371	.0021	.028	-.0044
	-2.0	.280	.0359	-.0318	.0004	.020	-.0050		-2.1	.179	.0357	-.0370	.0013	.019	-.0031
	-1.0	.280	.0353	-.0313	-.0009	.007	-.0021		-1.1	.180	.0352	-.0371	.0004	.009	-.0017
	0.0	.280	.0353	-.0314	-.0024	-.004	.0007		-0.1	.179	.0347	-.0371	-.0004	.000	-.0002
	0.9	.277	.0350	-.0308	-.0039	-.014	.0031		0.7	.181	.0351	-.0376	-.0015	-.009	.0014
	1.9	.283	.0365	-.0333	-.0055	-.028	.0065		1.7	.180	.0354	-.0373	-.0023	-.018	.0029
	2.9	.283	.0371	-.0337	-.0072	-.044	.0104		2.8	.180	.0364	-.0373	-.0033	-.029	.0046
	3.8	.280	.0379	-.0332	-.0086	-.063	.0149		3.7	.179	.0376	-.0370	-.0038	-.038	.0054
	5.8	.280	.0434	-.0345	-.0112	-.091	.0210		5.7	.175	.0408	-.0366	-.0056	-.061	.0082
	7.8	.271	.0485	-.0336	-.0126	-.119	.0247		7.6	.170	.0456	-.0365	-.0068	-.083	.0098
1.20	-8.1	.293	.0592	-.0537	.0178	.098	-.0243	2.20	-8.2	.148	.0423	-.0328	.0048	.073	-.0054
	-6.0	.296	.0536	-.0541	.0132	.067	-.0172		-6.1	.153	.0378	-.0329	.0038	.053	-.0052
	-4.1	.298	.0500	-.0536	.0078	.044	-.0114		-4.2	.157	.0351	-.0331	.0027	.035	-.0042
	-3.1	.295	.0488	-.0534	.0050	.029	-.0080		-3.3	.157	.0340	-.0331	.0020	.026	-.0034
	-2.1	.296	.0482	-.0534	.0026	.018	-.0051		-2.3	.158	.0331	-.0332	.0013	.018	-.0023
	-1.1	.297	.0479	-.0536	.0001	.007	-.0018		-1.3	.158	.0327	-.0333	.0005	.009	-.0013
	-0.2	.296	.0475	-.0533	-.0025	-.005	.0017		-0.3	.158	.0324	-.0332	-.0001	.000	-.0002
	0.7	.295	.0473	-.0526	-.0050	-.016	.0048		0.5	.159	.0326	-.0332	-.0009	-.009	.0011
	1.7	.295	.0481	-.0532	-.0073	-.028	.0079		1.5	.158	.0331	-.0331	-.0016	-.018	.0023
	2.7	.296	.0488	-.0533	-.0098	-.041	.0116		2.5	.158	.0339	-.0330	-.0023	-.028	.0034
	3.7	.298	.0504	-.0537	-.0129	-.058	.0158		3.5	.156	.0354	-.0328	-.0028	-.036	.0042
	5.7	.295	.0541	-.0530	-.0181	-.086	.0231		5.5	.153	.0385	-.0325	-.0041	-.057	.0054
	7.5	.290	.0596	-.0521	-.0219	-.116	.0300		7.4	.147	.0434	-.0325	-.0052	-.078	.0058
1.50	-7.8	.247	.0537	-.0490	.0114	.083	-.0165								
	-5.7	.251	.0490	-.0498	.0084	.058	-.0128								
	-3.8	.253	.0460	-.0504	.0052	.037	-.0089								
	-2.9	.254	.0451	-.0506	.0035	.027	-.0067								
	-1.8	.254	.0443	-.0506	.0017	.015	-.0041								
	-0.8	.254	.0439	-.0506	.0000	.004	-.0014								
	0.1	.255	.0437	-.0505	-.0016	-.006	.0008								
	1.0	.254	.0439	-.0504	-.0031	-.015	.0029								
	2.0	.253	.0443	-.0504	-.0047	-.026	.0055								
	3.0	.253	.0452	-.0501	-.0065	-.038	.0081								
	3.9	.252	.0469	-.0498	-.0082	-.051	.0106								
	5.9	.247	.0505	-.0490	-.0113	-.077	.0149								
	7.7	.242	.0555	-.0482	-.0134	-.100	.0181								

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TABLE IV.- AERODYNAMIC CHARACTERISTICS THROUGH ANGLE-OF-SIDESLIP
 RANGE AT $\alpha = 5^\circ$ - Concluded
 (b) Twisted and cambered wing configuration with modified leading edge

M	β , deg	C_L	C_D	C_m	C_l	C_Y	C_n	M	β , deg	C_L	C_D	C_m	C_l	C_Y	C_n
0.70	-03.7	0.194	0.0206	-0.0045	0.0044	0.045	-0.0105	1.70	-03.8	0.200	0.0398	-0.0331	0.0027	0.040	-0.0088
	0.1	.192	.0192	-.0031	-.0017	-.004	.0004		0.0	.200	.0371	-.0331	-.0010	-.003	.0002
	1.1	.191	.0193	-.0033	-.0033	-.016	.0032		1.0	.199	.0373	-.0328	-.0020	-.015	.0028
	2.1	.191	.0196	-.0037	-.0047	-.028	.0058		1.9	.198	.0378	-.0327	-.0029	-.025	.0051
	3.0	.192	.0206	-.0042	-.0064	-.039	.0085		2.9	.197	.0387	-.0324	-.0039	-.038	.0079
	4.0	.192	.0222	-.0044	-.0083	-.055	.0122		3.9	.194	.0400	-.0318	-.0047	-.050	.0102
	6.0	.192	.0268	-.0051	-.0116	-.088	.0199		5.8	.189	.0436	-.0306	-.0060	-.073	.0137
	7.9	.189	.0332	-.0057	-.0145	-.121	.0274		7.7	.191	.0498	-.0312	-.0076	-.101	.0177
0.90	-3.9	.215	.0231	-.0073	.0059	.052	-.0131	2.00	-3.9	.166	.0375	-.0280	.0014	.044	-.0066
	0.0	.212	.0208	-.0059	-.0009	-.001	-.0005		-0.1	.167	.0344	-.0282	-.0008	.001	.0007
	0.9	.212	.0208	-.0059	-.0027	-.014	.0026		0.8	.168	.0346	-.0283	-.0015	-.011	.0029
	1.8	.209	.0209	-.0060	-.0042	-.026	.0053		1.8	.166	.0349	-.0280	-.0021	-.021	.0049
	2.8	.212	.0223	-.0071	-.0059	-.039	.0084		2.8	.166	.0360	-.0279	-.0027	-.033	.0070
	3.8	.211	.0237	-.0073	-.0079	-.054	.0123		3.8	.164	.0373	-.0275	-.0032	-.043	.0087
	5.8	.209	.0280	-.0079	-.0115	-.087	.0206		5.7	.159	.0407	-.0267	-.0040	-.066	.0114
	7.7	.207	.0348	-.0090	-.0133	-.114	.0245		7.6	.154	.0456	-.0257	-.0044	-.088	.0129
1.20	-4.1	.263	.0411	-.0332	.0082	.050	-.0135	2.20	-4.1	.145	.0363	-.0250	.0010	.044	-.0067
	-0.2	.260	.0380	-.0315	-.0015	-.002	.0002		-0.3	.147	.0328	-.0251	-.0002	.005	-.0013
	0.7	.260	.0386	-.0329	-.0038	-.014	.0037		0.7	.146	.0327	-.0251	-.0007	-.006	.0005
	1.7	.259	.0390	-.0328	-.0064	-.027	.0074		1.6	.146	.0332	-.0250	-.0011	-.016	.0020
	2.7	.260	.0398	-.0327	-.0087	-.039	.0107		2.6	.145	.0341	-.0248	-.0014	-.027	.0037
	3.7	.258	.0409	-.0322	-.0111	-.053	.0144		3.6	.143	.0352	-.0245	-.0017	-.038	.0050
	5.6	.254	.0446	-.0306	-.0161	-.084	.0227		5.5	.139	.0384	-.0241	-.0022	-.058	.0071
	7.6	.249	.0509	-.0297	-.0200	-.116	.0303		7.5	.133	.0432	-.0234	-.0026	-.080	.0083
1.50	-3.8	.230	.0418	-.0375	.0044	.046	-.0113								
	0.0	.230	.0391	-.0376	-.0008	-.001	-.0007								
	1.0	.229	.0394	-.0374	-.0022	-.013	.0022								
	2.0	.228	.0398	-.0371	-.0035	-.024	.0047								
	2.9	.227	.0407	-.0368	-.0048	-.036	.0075								
	4.0	.224	.0418	-.0363	-.0061	-.049	.0102								
	5.8	.220	.0454	-.0350	-.0082	-.074	.0150								
	7.7	.213	.0505	-.0333	-.0100	-.101	.0192								

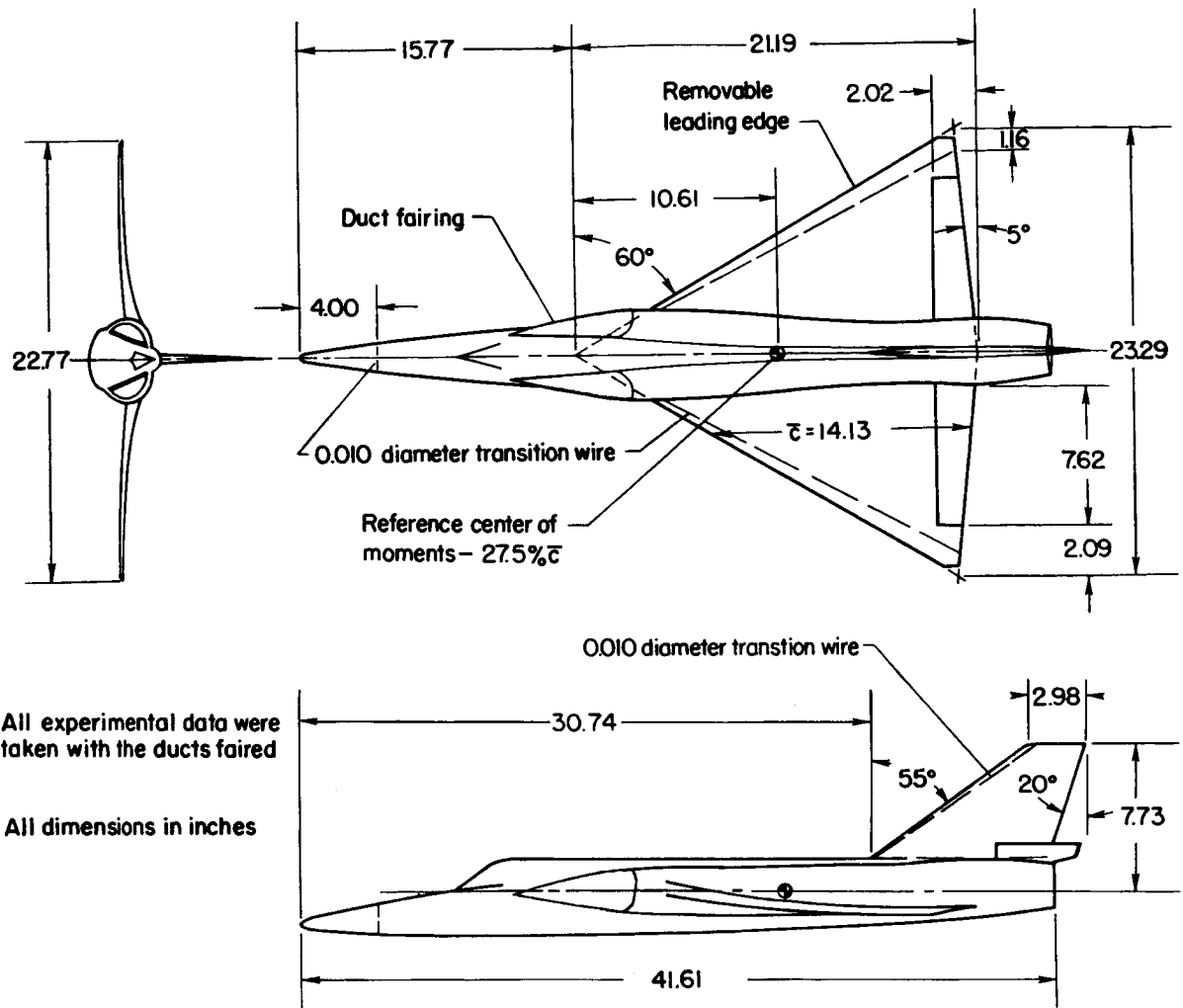
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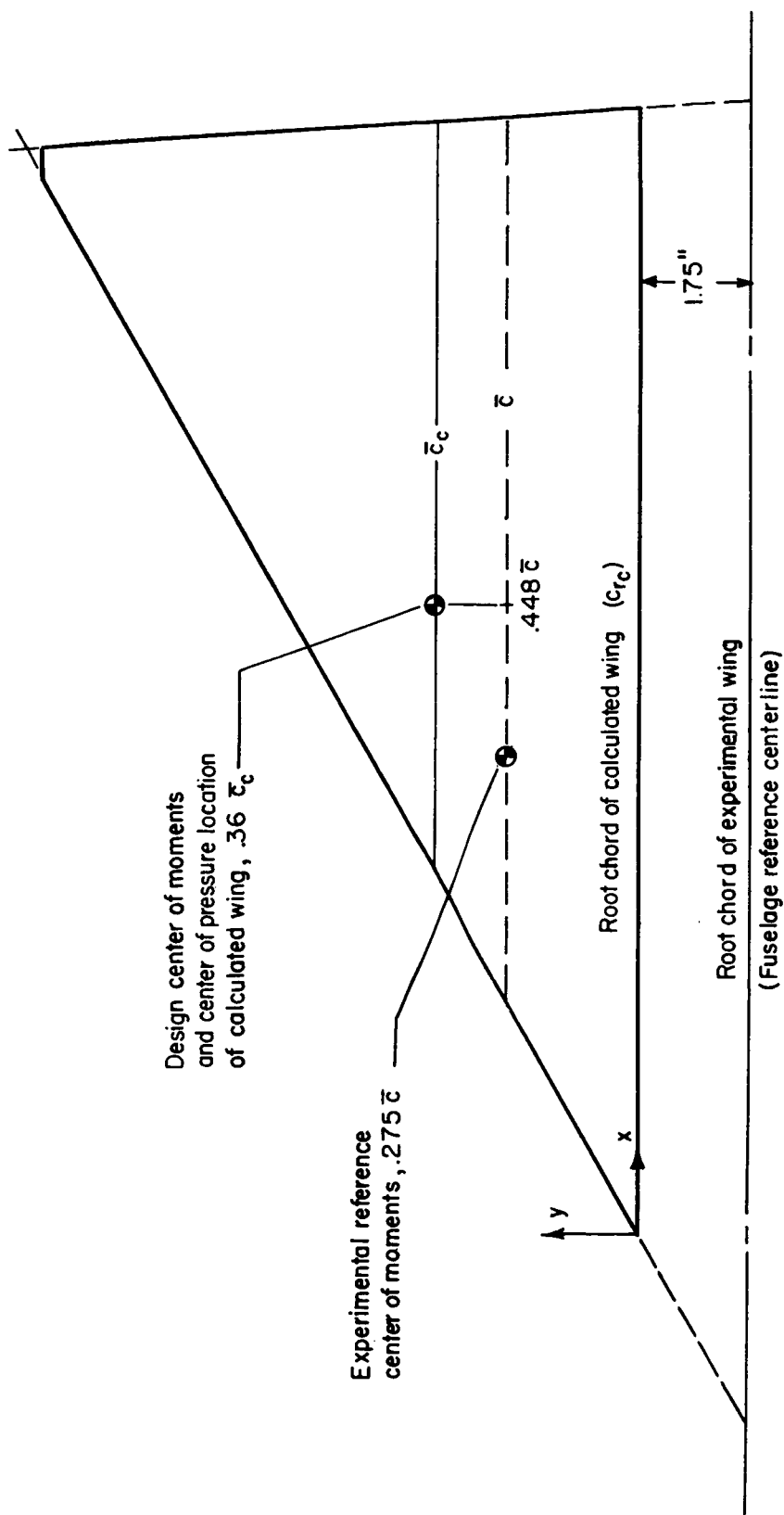
(a) Photograph of model.

Figure 1.- Model details and dimensions.



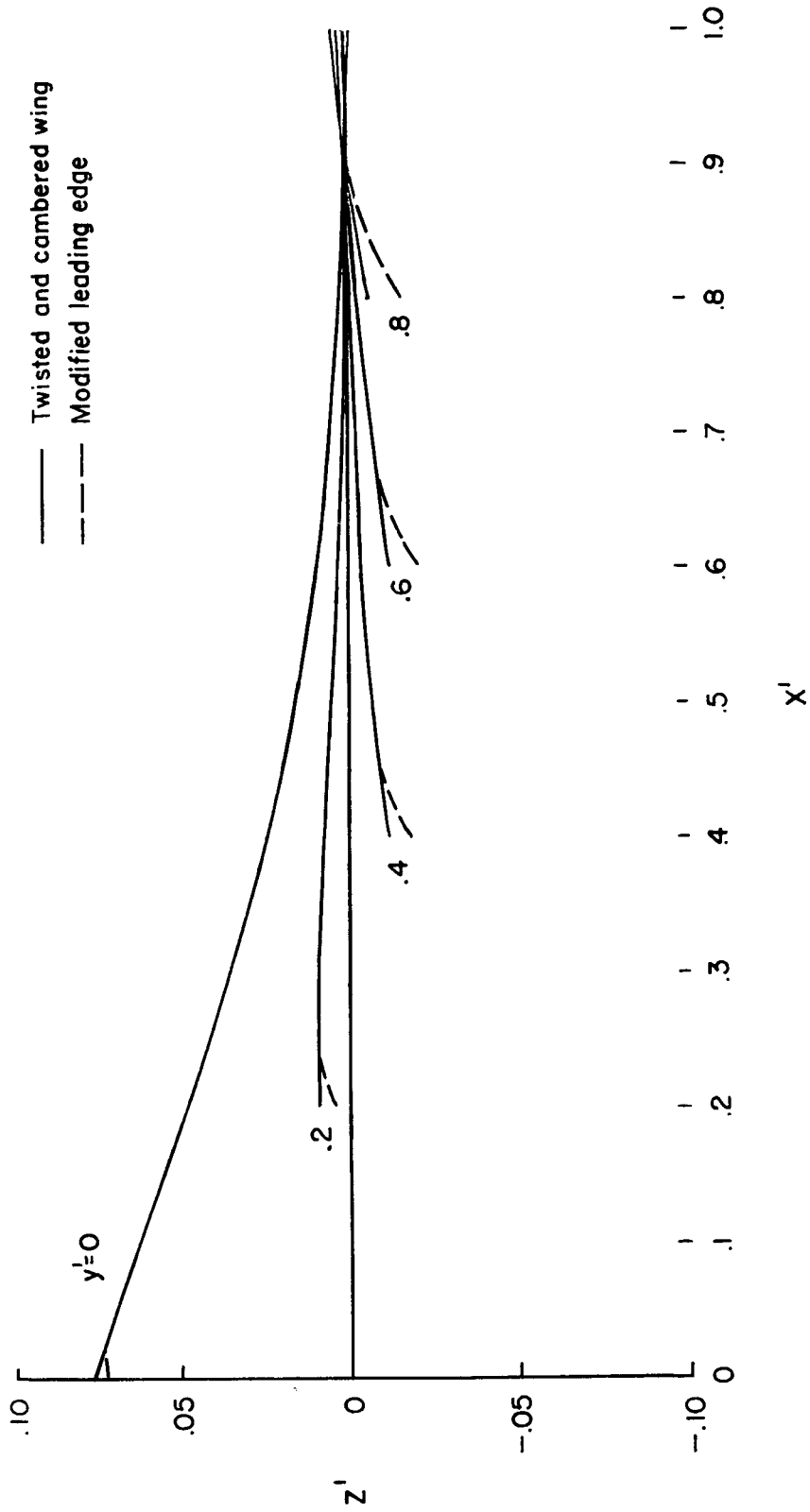
(b) Dimensional sketch of model.

Figure 1.- Continued.



(c) Wing plan-form details.

Figure 1.- Continued.



(d) Mean camber lines of twisted and cambered wing with angle of attack of fuselage reference center line at 0° .

Figure 1.- Concluded.

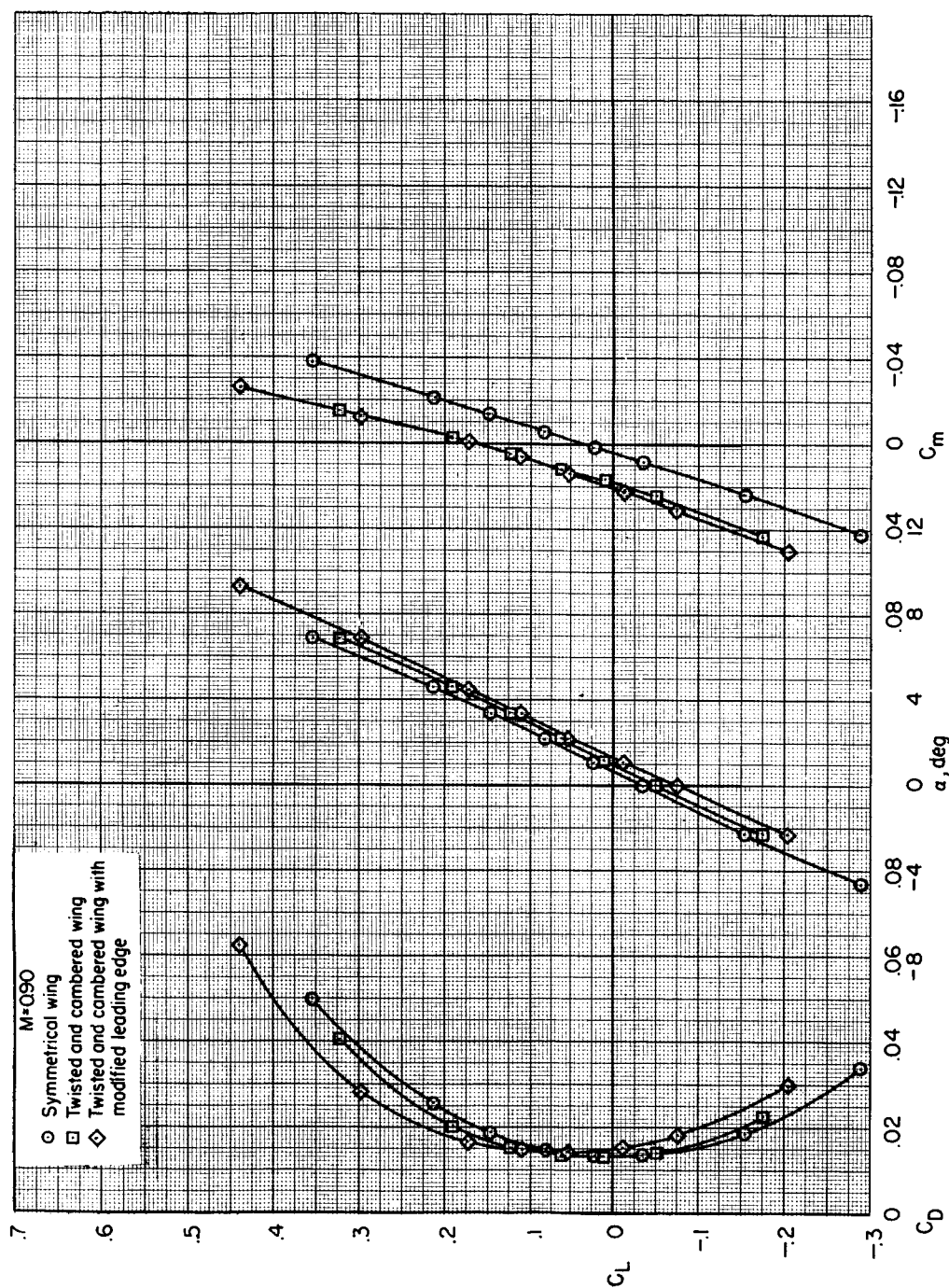
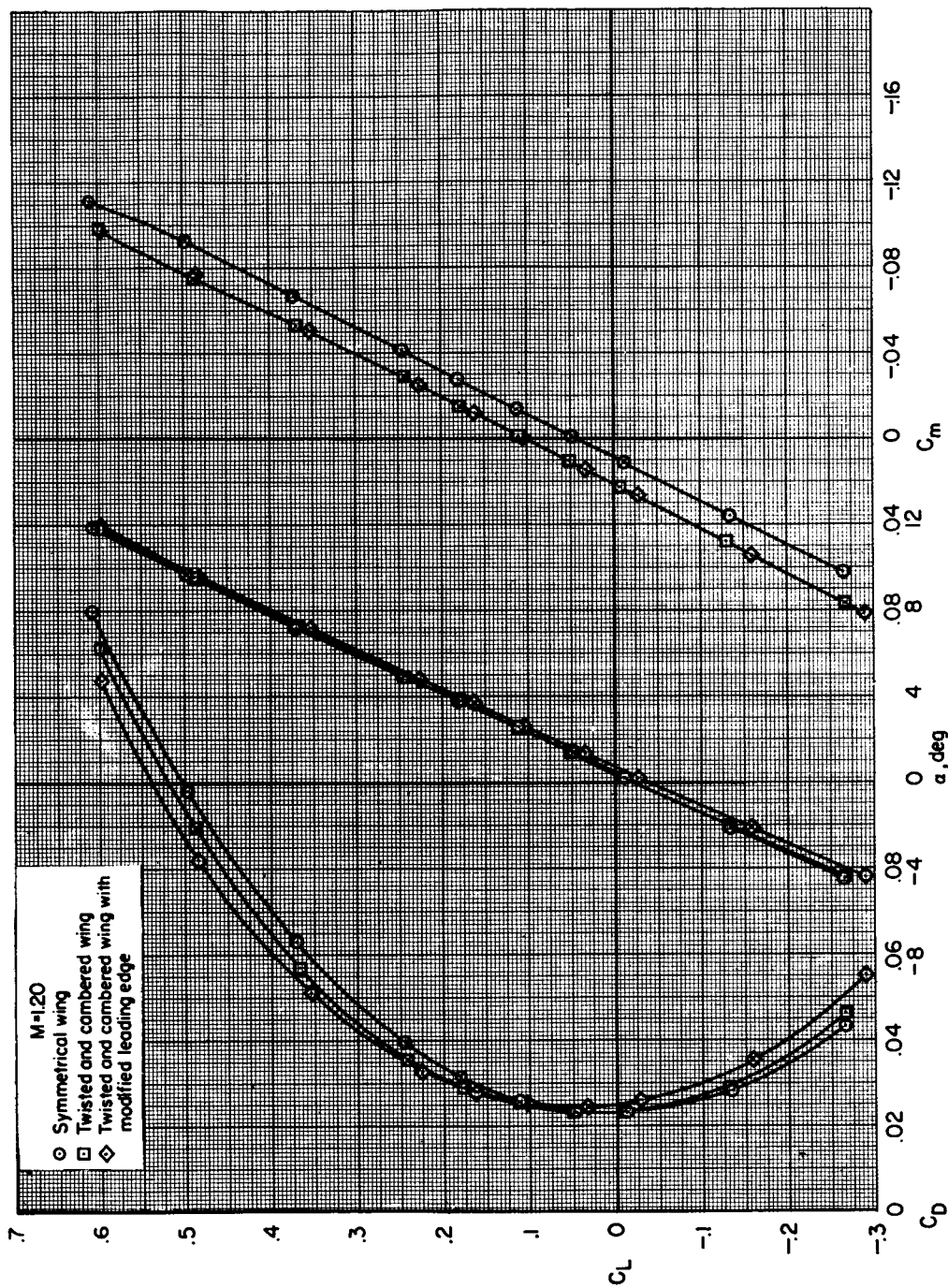
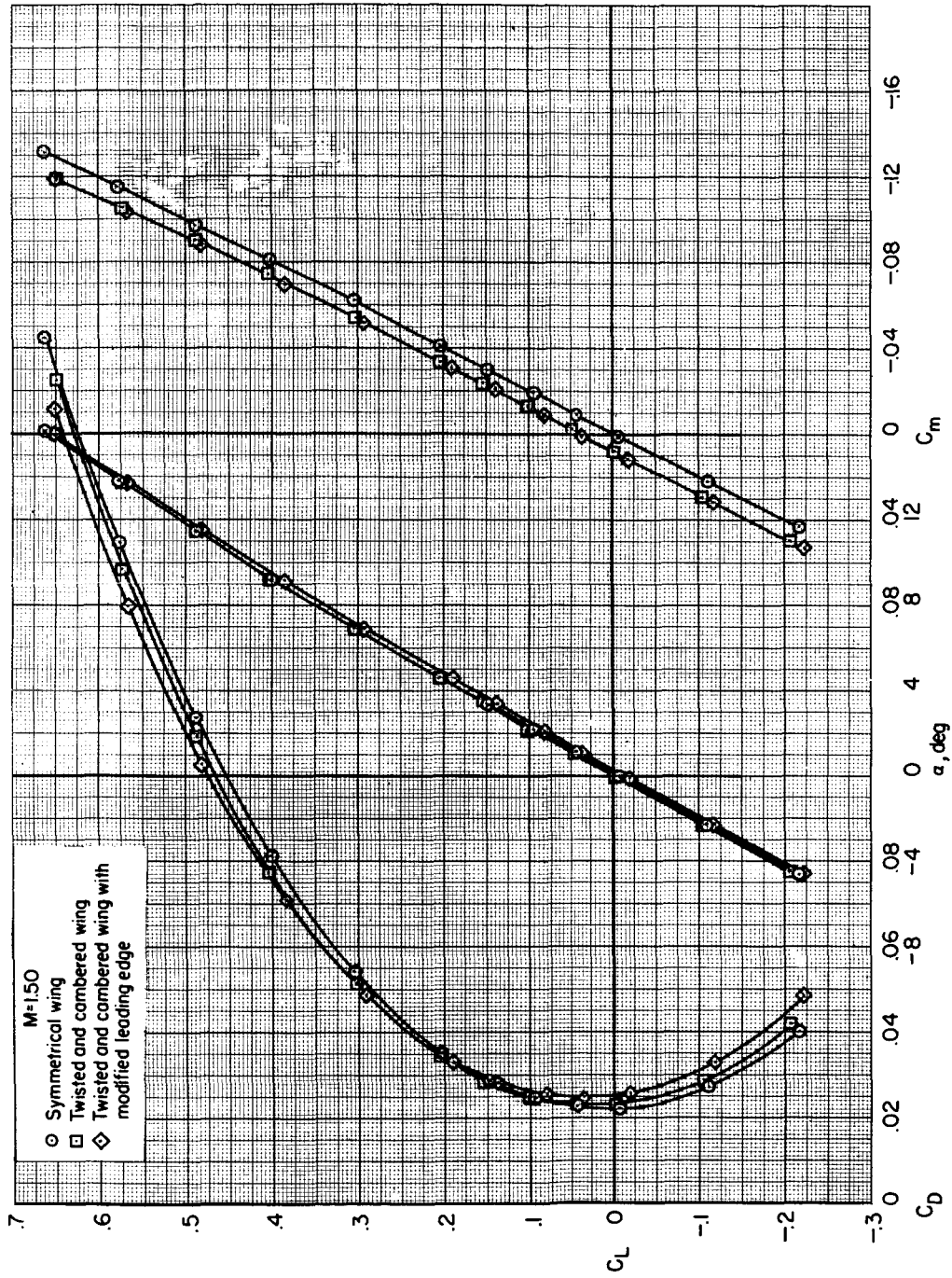
(a) $M = 0.90$

Figure 2.- Lift, drag, and pitching-moment characteristics.



(b) $M = 1.20$

Figure 2.- Continued.



(c) $M = 1.50$

Figure 2.- Continued.

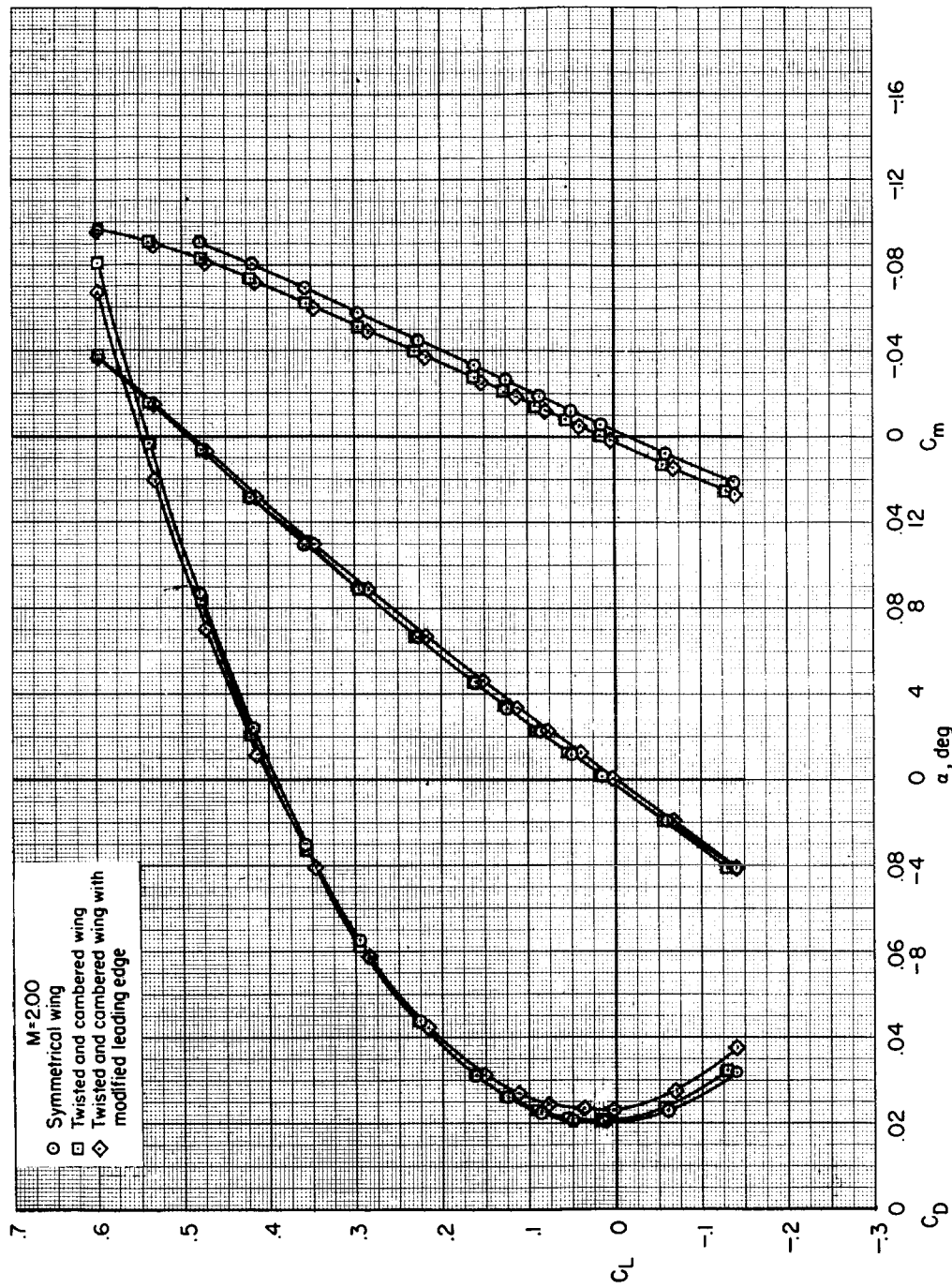
(d) $M = 2.00$

Figure 2.- Continued.

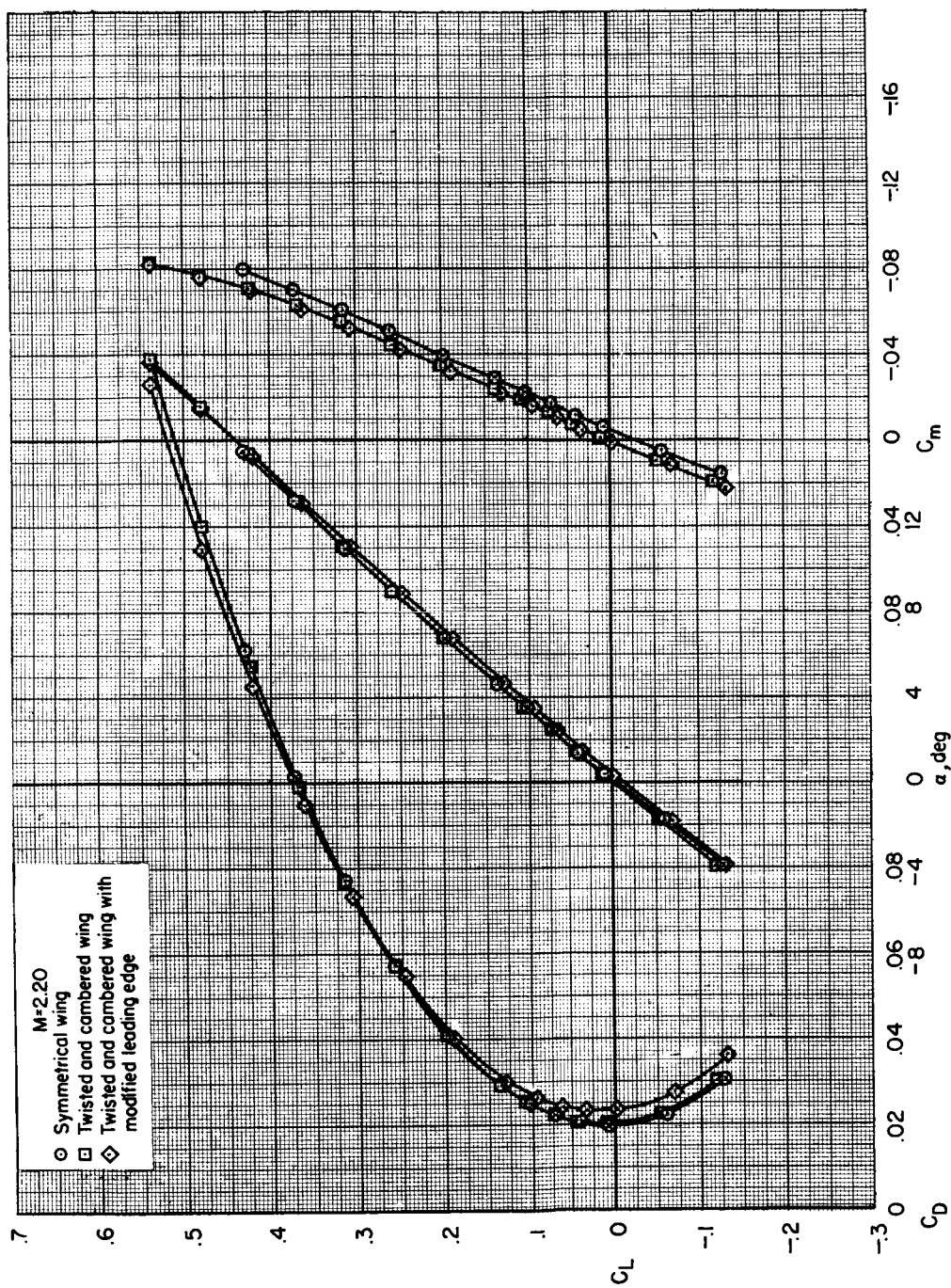
(e) $M = 2.20$

Figure 2.- Concluded.

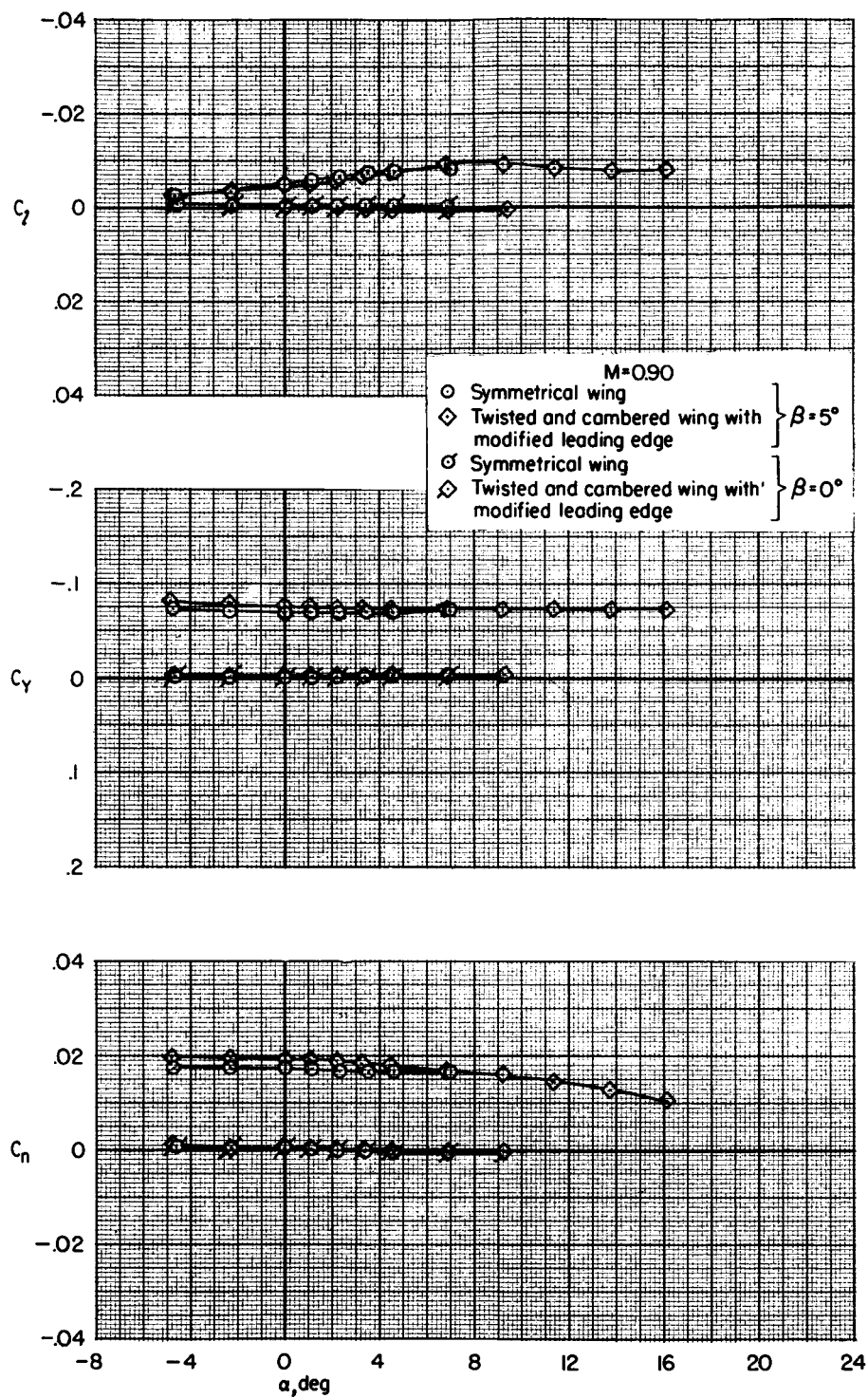
(a) $M = 0.90$

Figure 3.- Lateral-directional characteristics.

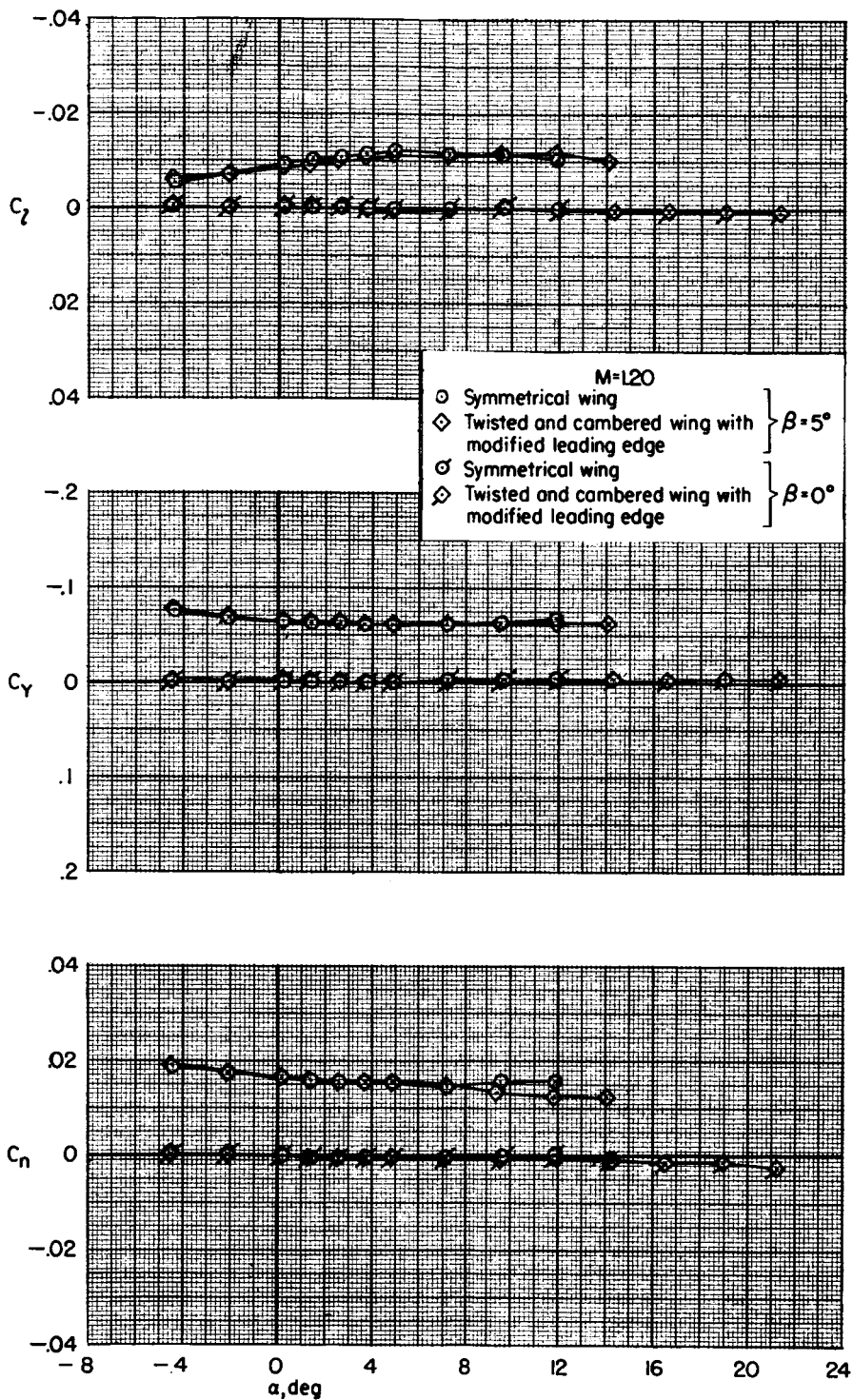
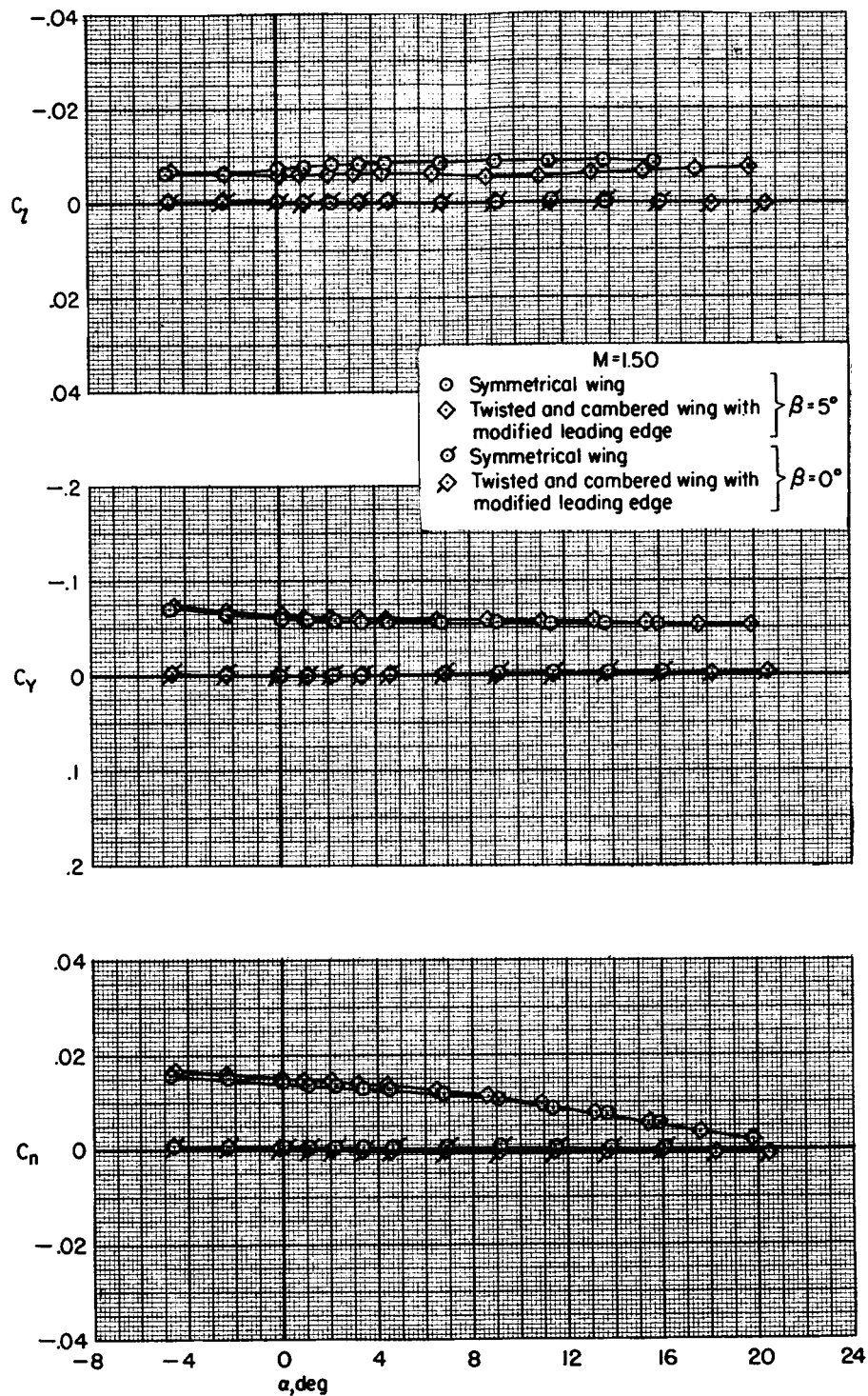
(b) $M = 1.20$

Figure 3.- Continued.



(c) $M = 1.50$

Figure 3.- Continued.

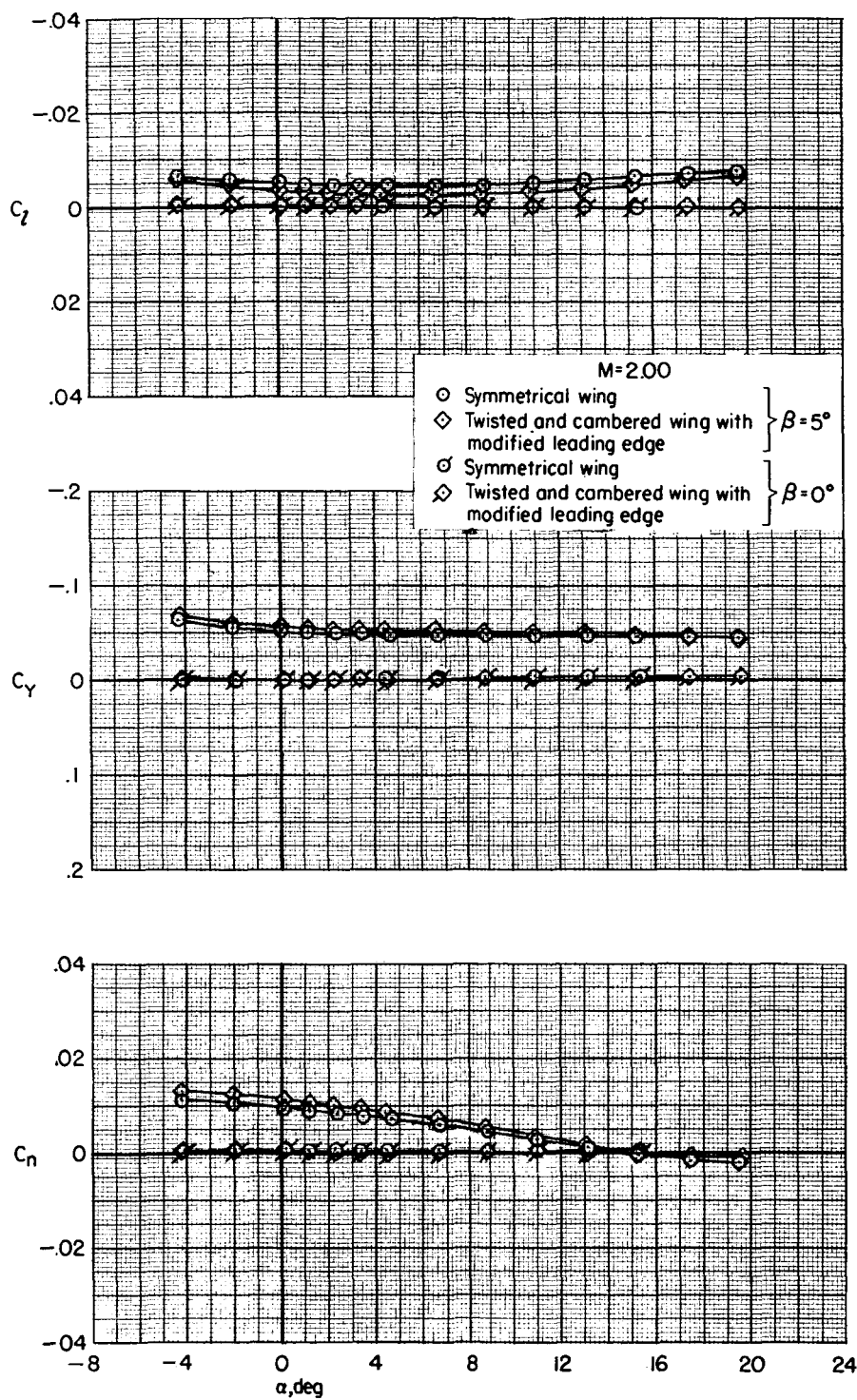
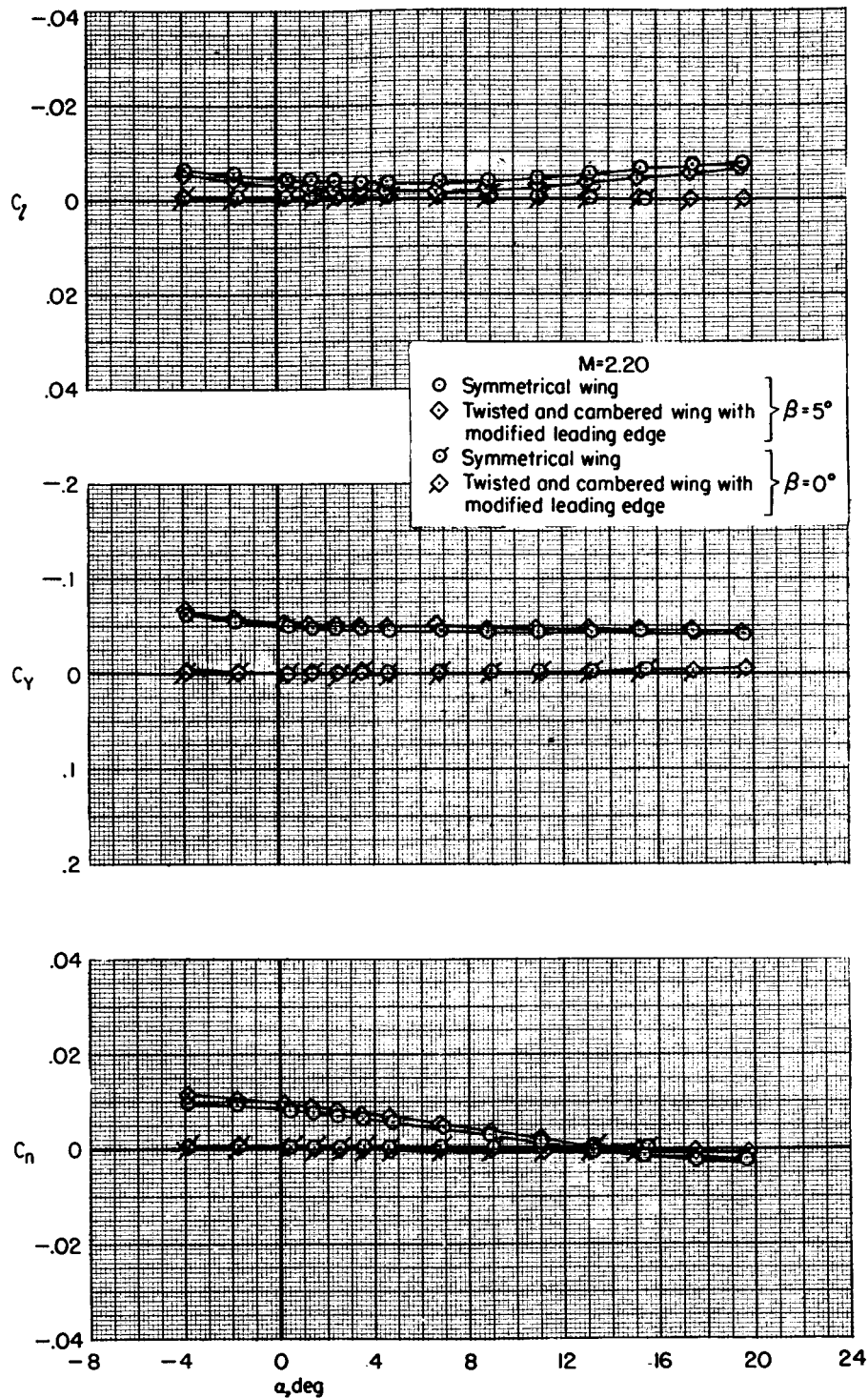
(d) $M = 2.00$

Figure 3.- Continued.



(e) $M = 2.20$

Figure 3.- Concluded.